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# EMPIRE OF REASON

*Exact Sciences in Indonesia*
*1840-1940*

BY

LEWIS PYENSON

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*For Benjamin Conrad*
*and*
*Russell McCormmach*

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## List of Abbreviations

Archives and institutions appear in roman typeface, published sources in italics.

| | |
|---|---|
| *Amst. Jaarb.* | Amsterdam, Koninklijke Akademie van Wetenschappen, *Jaarboek* |
| *Amst. Proc.* | Amsterdam, Koninklijke Akademie van Wetenschappen, *Proceedings* |
| *Amst. Versl.* | Amsterdam, Koninklijke Akademie van Wetenschappen, *Verslagen* |
| *Ann. Phys.* | *Annalen der Physik* |
| AV | Amsterdam, Voûte family archive |
| BAN | Bogor, Arsip Nasional, archives of the Algemeene Secretarie |
| *Bat. Jaarversl.* | Batavia, Koninklijk Magnetisch en Meteorologisch Observatorium, *Jaarverslag*. Published each year for the preceding year |
| *Bat. Verh.* | Batavia, Koninklijk Magnetisch en Meteorologisch Observatorium, *Verhandelingen* |
| BGS | Brief Gouvernements Secretaris, Netherlands East Indies |
| BOC | Bilthoven, private archive of Mevr. Nelke van Osselen-Clay |
| Bt | Besluit, Algemeene Secretarie, Netherlands East Indies |
| *BWN* | *Biografisch Woordenboek van Nederland*, ed. J. Charité, 2 vols (The Hague/Amsterdam, 1979-85) |
| *CIES* | Lewis Pyenson, *Cultural Imperialism and Exact Sciences: German Expansion Overseas, 1900-1930* (New York and Berne, 1985) |
| *Développement* | Netherlands, Bijzondere Comité voor de afdeeling der wetenschappen, Internationale Tentoonstelling te Luik 1930, *Le Développement des sciences aux Pays-Bas pendant le dernier demi-siècle* (Leiden, 1930) |
| diss. | Dr in wis- en natuurkunde proefschrift; Dr phil., Dr-ès-sciences, or Ph.D. dissertation. Medical and engineering doctorates are specifically indicated: Dr med. diss., Dr ing. diss. Printed dissertations are noted by granting university, not by location of printer; year of defense takes precedence over year of printing. |
| DRG | Delft, Rijkscommissie voor Geodesie, correspondence of the Rijkscommissie voor Graadmeting en Waterpassing |
| *DSB* | *Dictionary of Scientific Biography*, ed. Charles C. Gillispie, 16 vols (New York, 1970-80) |
| *Eeuw* | Jakarta, Koninklijke Natuurkundige Vereeniging, *Een Eeuw natuurwetenschap in Indonesië 1850-1950* (Jakarta, 1950) |

| | |
|---|---|
| *Encyc.* | *Encyclopaedie van Nederlandsch-Indië*, eds D. G. Stibbe and J. Stroomberg, 9 vols (The Hague, 1917-40) |
| *GT* | *Geneeskundig Tijdschrift voor Nederlandsch-Indië* |
| HBS | hoogere burgerschool |
| *HD* | *Hemel en dampkring* |
| ICWO | Indisch Comité voor Wetenschappelijke Onderzoekingen |
| KNMI | Koninklijk Nederlandsch Meteorologisch Instituut |
| KNV | Koninklijke Natuurkundige Vereeniging |
| LMB | Leiden, Museum Boerhaave |
| LO | Santa Cruz, McHenry Library, Mary Lea Shane Archives of the Lick Observatory |
| LP | Documents in the author's possession |
| LS | Leiden, Huygens Laboratorium, archives of the Leidse Sterrewacht |
| LSA | Leiden, Huygens Laboratorium, archives of the Leiden Station in South Africa, in LS |
| LUB | Leiden, Universiteits-Bibliotheek |
| *Min.* | *Minerva: Jahrbuch der gelehrten Welt* (Leipzig, 1892, *et seq.*) |
| *MN* | *Monthly Notes of the Astronomical Society of Southern Africa: Volumes 1-15 Condensed* (Cape Town, 1980) |
| *NINC Hand.* | *Handelingen van het Nederlandsch-Indisch Natuurwetenschappelijk Congres*, from first (*1° NINC Hand.*) in 1919 to seventh in 1935. |
| *NP* | *Nederlands Patriciaat* (The Hague, 1910, *et seq.*) |
| *NT* | *Natuurkundig Tijdschrift voor Nederlandsch-Indië* |
| NWR | Natuurwetenschappelijke Raad van Nederlandsch-Indië |
| NYH | New York, American Institute of Physics, Niels Bohr Library, Ejnar Hertzsprung microfiches |
| *Ontwikkeling* | Jakarta, School tot Opleiding van Indische Artsen, *Ontwikkeling van het geneeskundig onderwijs te Weltevreden 1851-1926* (Weltevreden, 1926) |
| RGA | Rotterdam, Gemeente Archief, Elie van Rijckevorsel papers |
| TH | technische hoogeschool or institute of technology |
| Tzg. Ag. | Terzijde gelegd agenda, Algemeene Secretarie, Netherlands East Indies |
| univ. | universiteit, universität, université, university |
| USS | Utrecht, Sonnenborgh Sterrewacht, archives; presently with the Astronomy Department of the Rijksuniversiteit, Princetonplein |
| UUM | Utrecht, Universiteits-Museum |
| WAS | Washington, National Air and Space Museum, Frank Schlesinger microfilms |
| WS | Private archive of Mevr. and Dr med. Jacques Walburgh Schmidt, formerly of The Hague |

## On Sources and Names

With the exception of frequently used sources contained in the List of Abbreviations, complete bibliographical information appears with the first reference to a document in each chapter. Thereafter a short title is used. When archival documents are located in dossiers, dossier title always appears in sequence before document identification.

In the following pages, Dutch institutions and titles have for the most part been translated into English. The Ministerie van buitenlandsche zaken appears as the ministry of foreign affairs, the Technische Hoogeschool Bandung as the Bandung Institute of Technology, *privaatdocent* as privatdocent, and *buitengewoon hoogleeraar* as associate professor. Certain terms that, in translation, might give rise to confusion are retained. The Bataviaasch Genootschap van Kunsten en Wetenschappen is not referred to as the Batavian Society, and university *lectoren* are not called readers. To emphasize the special character of colonial administration, which had directors of departments rather than ministers of ministries, I use the Dutch word *departement* when referring to portfolios under the governor general. The Dutch *gymnasium*, a classical secondary school, is italicized to emphasize that it is not a place of athletic exertion. The spelling *conservateur* is in one case retained. Proper nouns are not modernized to follow the mid-twentieth-century reform of grammar and orthography. Capitalization in Dutch titles has been made to follow North-American conventions for Romance languages.

Dutch place names generally follow modern usage in the Netherlands, although the government is held to sit at The Hague. Geographical lexicons of Indonesia have undergone a number of changes over the past 150 years. I follow conventions current at the end of the colonial regime. The reader will see Buitenzorg instead of Bogor, Soerabaja for Surabaya, and Celebes in place of Sulawesi; Bandung is nevertheless substituted for Bandoeng and Aceh for Atjeh. Weltevreden is retained as a suburb of Batavia although today it lies at the center of Jakarta. I mean no disrespect to Indonesian colleagues when I use the Dutch East Indies and Indonesia interchangeably.

# Preface

For hundreds of years, dispassionate observers of Western civilization have noted Dutch intellectual achievements.[1] Why this is so during the modern period will be suggested in what follows. The matter is of intrinsic, general interest, although it has unfortunately been neglected. Scholars, by nature timid and ponderous, do perceive that matters of cultural leadership transcend the accidents of linguistic demography, but the perception has done little to extend Dutch history beyond a relatively small circle of specialists and patriots.

The usual motivations for studying a particular culture and period find little place in the following pages. The present volume, conceived in a subpolar and provincial environment lacking most of the relevant sources, originates in something other than specialist or patriotic ardor. It has been undertaken as part of an investigation of the exact sciences and cultural imperialism in the post-industrial period. A discussion of parameters and limits may be read in the introduction to a companion work, but it is not irrelevant to reconsider some of the points here.[2]

The general investigation concerns the diffusion of 'pure' sciences beyond Europe during the nineteenth and twentieth centuries. The focus has been directed toward European nationals who went abroad as part of government policy and academic practice, but who did not initially see themselves as emigrants. At issue are the aims and policies of metropolitan governments and university scientists, as well as the aspirations and anxieties of researchers on the 'periphery.'

Concentrating on the century after around 1840 facilitates studying the outward movement of the exact sciences in relation to imperialism. The latter, ideologically-charged notion has been the object of intense scrutiny over the past few generations. Imperialism is of interest insofar as the phenomenon may be said to postdate the industrial revolution. Attention goes to examining how the socioeconomic and political forces of imperialism may have interacted with both the production and the form of 'pure' scientific discourse—that is to say, with scientific *texts*—on the 'periphery' of the scientific world. Cultural imperialism is intended to

1 To mention only two recent, persuasive accounts of the sixteenth and seventeenth centuries: Witold Rybczynski, *Home: A Short History of an Idea* (New York, 1986), pp. 15-75; Simon Schama, *The Embarrassment of Riches: An Interpretation of Dutch Culture in the Golden Age* (New York, 1987).

2 *CIES*.

denote how one impractical cultural activity related to imperialist practice.

The inquiry bears on two issues recently addressed by historians of science: the extent to which 'pure' scientific discourse may reflect the socioeconomic situation of scientists who produce it; the extent to which 'pure' scientific discourse may be used by governments to achieve political or economic goals.

Regarding the first issue, much interest continues to focus on the socioeconomic roots of scientific activity, and considerable effort has gone toward studying the response of researchers to imperatives originating beyond the norms of their scientific and academic communities; writers have also examined the formation of scientific norms in response to social and political forces. The literature centers on biomedicine, ecology, and the social and human sciences, and it confirms a traditional view that social and political values are central to these disciplines. Although sociologists and anthropologists now study the 'tribes' of high-energy physicists and radio astronomers, exact sciences have less frequently been plumbed by historians interested in how scientific discourse has related to sociopolitical pressures.[3] In astronomy and physics, it would be difficult to imagine a setting more highly charged with such pressures than a colonial observatory or university.

The issue of political means and ends may be seen in the way that science, today, figures in foreign policies. Governments publicize scientific achievement as an advertisement of cultural and economic strength. They also use scientific activity overseas to legitimize a physical presence or sphere of influence. The present book documents the international, political dimensions of Dutch science beginning around the middle of the nineteenth century.

The use made of the exact sciences in foreign policy lies at the center of any notion of cultural imperialism, a term that continues to generate strong emotions. Writers have for the most part not considered how impractical scientific resources furnished political leverage in contested or uncommitted parts of the world. A focus on the 'pure,' exact sciences offers the possibility of distinguishing economic motivations from cultural ones. A sophisticated, agricultural-experimentation station in a colony may contribute to botanical knowledge, but its purpose is to advance local production and export. An astronomical or geophysical observatory extends no promise of immediate financial gain; its establishment relates to general, cultural objectives and to questions of international prestige. Such observatories instruct us in the way that 'pure' scientific institutions have served to entrench a metropolitan power in 'peripheral' territory.

3 A recent and balanced survey may be found in Vojin Milić, "Sociology of Knowledge and Sociology of Science," *Social Science Information, 23* (1984), 213-73.

Exploring pure science in an imperialist setting is an undertaking in the social history of science. Research in this field begins with general, historical questions instead of with a brilliant scientific publication. It focuses on "the immediate professional environment in which the scientist carried on his daily activities—the research group or groups with whom he works, the academic associations to which he belongs, the university or research institute with which he is associated."[4] In social history of science, much attention goes to the origin, training, and temperament of scientific researchers and those directly associated with their projects. Matters of financing, laboratory organization, and professional advancement move to center stage. Especially in situations beyond Europe, relevant information is found in the name, racial origin, and tasks of laboratory assistants, as well as in the daily activity of senior researchers.

Social historians of science, like the *annaliste* writers who inspire them, give short shrift to the lives of political chieftains. This predilection, grounded in a skeptical attitude toward political authority, is encouraged by the small part of governmental budgets given to projects in pure scientific research. The following pages consider the relationship of general policy issues to contingencies associated with funding, but the aim is not to elaborate on political power and its prerogatives. The scientific character of institutions and their staff remains paramount. The geography of centers for advanced research in colonial and neocolonial locations is only beginning to be mapped. This historical question demands an immediate focus on the agents of pure learning—the scientists.

In the Dutch East Indies, astronomy and physics received financial support from politicians and philanthropists in both the colony and the motherland. Examining pure learning in this colonial setting reveals a peculiar intertwining of the government, academic, and private sectors. I have suggested that this linkage departs from the pattern of support for the exact sciences elsewhere during the nineteenth and twentieth centuries.[5] The present volume situates Dutch scientific activity for comparisons, but it is chary of extracting unnatural confessions from circumstances and documents. A number of figures receive close scrutiny who shall never achieve apotheosis. We see their wealth, family situation, educational trajectory, and internationalist attitude, their ambitions and doubts. Only by studying the lives of such astronomers and physicists beyond the North-Atlantic world shall generalizations be won and comparisons entertained.

Cultures peripheral to Western Europe are deprived of their history of science, Susantha Goonatilake has argued; the conqueror's chronicles

4 Shigeru Nakayama, transl. Jerry Dusenbury, *Academic and Scientific Traditions in China, Japan, and the West* (1974; Tokyo, 1984), p.p. ix-x.

5 Lewis Pyenson, "Pure Learning and Political Economy: Science and European Expansion in the Age of Imperialism," *New Trends in the History of Science*, eds Robert Visser, H. J. M. Bos, H. A. M. Snelders, and L. C. Palm (Utrecht, in press).

undervalue the life of the conquered.[6] To recover their history, the vanquished often had to travel to the center of empire and speak the victor's language. Such a tour, in an earlier time, resulted in a mirror image of what the imperialists produced for their own culture: Peripheral peoples glorified their authentic and indigenous achievements.[7] Historiography advances. Historians on the scientific periphery have begun to remand hagiography to scientist colleagues. Their progress is due in no small measure to the labors of archivists and librarians, who have amassed the documents required for balanced and sophisticated narrative.

I am indebted to staff at the archives on which this book draws. The reader will find the most important of these listed following the Table of Contents. It is a pleasure, in addition, to thank librarians at the Arsip Nasional in Jakarta, the Perpustakaan Museum Nasional in Jakarta, the Perpustakaan Pusat Institut Teknologi Bandung, the Badan Meteorologi dan Geofisika in Jakarta, the Koninklijke Bibliotheek in The Hague, the Universiteits-Bibliotheek in Leiden, the Bibliotheek of the Technische Universiteit Delft, the Bibliothèque Nationale in Paris, the Library of Congress in Washington, the United States Naval Observatory Library in Washington, the National Library for the History of Medicine in Bethesda, the libraries of the Smithsonian Institution, the university libraries in Princeton, and finally the Blacker-Wood, McLennan, Islamic, and Osler libraries at McGill University in Montreal. My work could not have proceeded without the professional assistance of the Interlibrary Loan Service of Vanier Library at Concordia University, in Montreal, and its head, Ms Wendy Knechtel.

For their help regarding various points, I thank Mevr. Pauline Beskers-Smulders and Dr T. de Groot of the Rijksuniversiteit Utrecht; Prof. dr Gerardus J. van der Plaats of Maastricht; Dr med. P. A. Voûte of Amsterdam; Mevr. and Dr med. Jacques Walburgh Schmidt, formerly of The Hague; Dr E. Dekker, formerly of the Museum Boerhaave in Leiden; Mej. Dra F. van Anrooij of the Tweede Afdeling, Algemeen Rijksarchief, The Hague; Mevr. F. C. Hartman of the Centraal Register van Particuliere Archieven, The Hague; Dr S. W. G. de Clercq of the Universiteits-Museum Utrecht; Ir H. C. Pouls of the Rijkscommissie voor Geodesie in Delft; Prof. dr H. A. M. Snelders and Drs Lodewijk Carel Palm of the Instituut voor Geschiedenis der Natuurwetenschappen in Utrecht; Tuan Machfudi Mangkundilaga of the Arsip Nasional in Jakarta; Tuan Walis Utomo of the Badan Meteorologi dan Geofisika in Jakarta; Mevr. Joanneke de Bruin, now of West Sussex, England; Ms Elaine Louw of Montreal; and Prof. Susan Sheets-Pyenson. Prof. Dr Bambang Hidayat of the Bosscha Observ-

6 Goonatilake, *Aborted Discovery: Science and Creativity in the Third World* (London, 1984).

7 A recidivist legacy may be found in a prize recently offered by the Third World Academy of Sciences, located at the International Centre for Theoretical Physics at Trieste, for the best study of the achievements of a Third-World scientist before 1900. Sociedad Latinoaméricana de la Historia de las Ciencias y de la Tecnología, *Boletín informativo*, N° 13 (Mar 1987), p. 13.

atory in Lembang introduced me to *wayang golek* on a cloudy Saturday evening. Kornelia and Peter Brown of Montreal lent me puppets from their *wayang purwa* collection.

Support for this research has been received from the Social Sciences and Humanities Research Council in Ottawa, the American Council of Learned Societies in New York, the American Philosophical Society in Philadelphia, the Short Term Visitors Program of the Smithsonian Institution, and the Herbert C. Pollock Award of the Dudley Observatory in Schenectady. The present publication has been supported by the Dudley Observatory and the Vice-décanat à la recherche, Faculté des Arts et Sciences, Université de Montréal. Parts of chapters one, two, and three have appeared in *Historia Scientiarum* and *Annals of Science*, and part of chapter four appears in the proceedings of a conference on new trends in the history of science, held in connection with celebrations of the 350th anniversary of the Rijksuniversiteit Utrecht. Much of the writing was done while Visiting Fellow in History of Science at Princeton University; I am grateful to the director of the host program there for tolerating my low visibility during this time.

Dozens of locations in both Indonesia and the Netherlands contain documentation about the exact sciences during the final century of Dutch rule in the Malay archipelago. Material is abundant for treating topics bearing on the present volume. Future studies related to devolution include the first generation of native Indonesian scientists and the rise of instruction in Bahasa Indonesia; among the ministers of state deserving special attention is the biologist Jacob Christiaan Koningsberger; from the applied side, there would be much interest in a new evaluation of petroleum geophysicists. I hope that my framework may stimulate further research and accommodate future findings.

Senneville

*Frontispiece*: The monster head Raksasa devouring the goddess of love Dewi Ratih, representing a lunar eclipse in Balinese mythology. It is a variant of the South-Asian Hindu pantheon, where the head Rāhu is also the ascending lunar node, and where Devī Rātrī is goddess of the night.

# 1
# Imperious Metropolitan Knowledge

## Masters: A Golden Age of Science

The Dutch empire in Indonesia is exceptional. It was not so long-lived as the Portuguese, so vast as the Spanish, so diverse as the French or British or Ottoman. Unlike British and French colonies, the Dutch East Indies never saw the entrenchment of a large colonial elite—or, indeed, a significant colonialist settlement. For much of its rule over Indonesia, the Dutch navy paled in strength beside European and Asian counterparts. The master's language never took root to an extent comparable with the situation in French Africa and British India. It remains that for three-and-a-half centuries, European rivals and many indigenous regents recognized, with only a short hiatus, Dutch hegemony.

Dutch expansion overseas coincided with the happy invention of the Dutch Republic and its felicitous successor, the Kingdom of the Netherlands. Although it would be an exaggeration to claim that cultural achievements are byproducts of material well-being, the golden ages of art and science in both the seventeenth and the early twentieth centuries were also ages of economic prosperity. The encouragement of higher learning requires an openminded spirit on the part of civil authorities and commercial proprietors. A culture more tolerant than the Dutch would be hard to find.

Learning, whether of the useful or useless variety, requires institutional support. In the seventeenth century, the institutions of excellence were elite academies. With the eighteenth century came more broadly based scientific societies. Between 1840 and 1940 universities emerged as the preferred locations for generating new knowledge. There is no logical necessity for having the progress of knowledge depend on schooling juvenile minds, on impressing future customs officials and mine inspectors with the sanctity of pure learning. Such a system is not self-contradictory, however, and once established it placed savants on public display. The system rewarded discipleship, pomposity, and prodigious reams of print. For nearly a hundred years, settings slow to imbed scientific research in pedagogical structures fell away to scientific obscurity.

By the sixth decade of the nineteenth century, Dutch academics had absorbed the research ethic of their German colleagues to the east and cemented a fluid hierarchy of university teaching posts into a durable, differentiated whole. At the top came the *gewoon hoogleeraar*, or chair professor, with all the prerogatives and prestige of German, British, and French homologues. To handle increasing enrolments economically, university authorities received permission in the 1820s to fill the position of *buitengewoon hoogleeraar*, or associate professor, who received a salary substantially lower than that of the man with the chair. In practice, and by the last quarter of the nineteenth century in statute, the associate professor held a tenured appointment. The associate professorship—modeled upon the German *extraordinarius* position—competed with a second traditional, junior appointment, that of the *lector*—roughly equivalent to a British reader. *Buitengewoon hoogleeraar* and *lector* might earn comparable salaries, but an associate professor was the senior in privilege. An associate professor had a professorial title, with its connotation of having discovered and mastered arcane knowledge. A *lector* was there to 'read' the introductory courses, and on this activity his income depended. The late nineteenth century saw activation of a final learned borrowing from Central Europe—that of the *privaatdocent*. Typically, the privatdocent would be a secondary-school teacher and laboratory or observatory assistant who received no salary in exchange for the privilege of offering a course on a new topic.

The introduction of the privatdocent category came as one feature of an extensive law of 1876 which entrenched the new pedagogical ideology in higher education. The law provided, first, for a national reorganization of the three universities to have survived the first half of the century—Groningen, Utrecht, and Leiden. The reorganization standardized salaries and pensions, although enterprising academics could still negotiate handsome supplements by directing institutes, laboratories, observatories, or seminars. The law prepared the ground for elevating the Amsterdam Athenaeum into a municipally controlled university. These changes concluded a modernization begun in 1863 with the establishment (by Jan Rudolf Thorbecke, then minister of the interior) of the *hoogere burgerschoolen* (HBS). The latter were Dutch counterparts of German *Realschulen* where science and modern languages took the place of Greek and Latin, which dominated the classical *gymnasia*. Thorbecke's model came from Germany, but the adaptation proved happier than the inspiration: All five of the first Dutch Nobel laureates studied at least for a time at a HBS.[1]

1 The late nineteenth-century changes are treated in Klaas van Berkel's illuminating survey, *In Het Voetspoor van Stevin: Geschiedenis van de natuurwetenschap in Nederland 1580-1940* (Amsterdam, 1985), pp. 132-8. On the scientific impact of the HBS: Bastiaan Willink, "Een Inleiding tot de tweede gouden eeuw: De wetten van 1863 en 1876 en de wedergeboorte van de Nederlandse natuurwetenschap," *Hollands Maandblad*, 22 (1980), 3-9; J. L. Oosterhoff, "De Opkomst van een 'vaderlandsche natuurkunde' aan de Leidse Universiteit in de tweede helft van de negentiende eeuw," in *Een Universiteit herleeft: Wetenschapsbeoefening aan de Leidse Universiteit vanaf de tweede helft van de negentiende eeuw*, ed. W. Otterspeer (Leiden, 1984), pp. 103-24, esp. pp. 104-6. M. Groen has

The changes in higher education in the Netherlands, preceding Dutch industrialization by a generation, took place with little opposition. In part this was because the Dutch system continued to encourage professors to deal with both pure and applied problems. Well into the twentieth century, the Dutch had only one institute of technology—that at Delft—and no federal reservoirs of technical expertise to compare with Germany's Physikalisch-Technische Reichsanstalt, France's Bureau des longitudes, or America's National Bureau of Standards. Professorial collaboration in practical matters dissuaded the Dutch government from establishing a special naval observatory. The HBS furnished exactly what the ecumenical universities required in the way of preparation and attitude.

Ecumenicism is reflected by the notable facility of Dutch academics in crossing disciplinary boundaries, especially in the exact sciences. The founder of the Royal Netherlands Meteorological Institute, for example, who figures prominently in the following pages, held positions in mathematics, physics, mineralogy, and meteorology, and made contributions in all these fields. The Dutch pioneered physical chemistry (and won two early Nobel prizes for their work) when the field had barely received sanction as a discipline. Universities responded quickly to new trends—their support for theoretical physics, astrophysics, and radiology being cases in point. The low profile of pure mathematics encouraged interdisciplinarity. In contrast to the legions of pure mathematician in Germany and France, the Dutch valued mathematics primarily as a tool for understanding the physical world. Dutch physicists and chemists knew how to find the mathematical overtones of nature's laws, and they freely followed the lead of any promising mathematical expression. Whereas Dutch society may have been divided into a large number of special-interest groups, the union of whose vertical structures composed the body politic, Dutch science was notably free from disciplinary sclerosis or pillarization.

Disciplinarization in modern science has been seen as essential for the advancement of learning. Disciplines certainly create acolytes and the circumstances to favor their employment, but they may just as surely discriminate against as encourage new ideas.[2] In the Netherlands, astonishing innovation occurred in astronomy, physics, and geophysics without the presence of a disciplinary base—the major astronomy and physics journals and societies emerging only in the 1920s. Astronomers, physicists, and geophysicists found inspiration in mathematics, chemistry, and descriptive

emphasized that *buitengewone hoogleeraren* received royal sanction in 1825; the position was suppressed in favor of the *lectoraat* in 1876 (except at the new University of Amsterdam), although it came back to the federal universities in 1905. M. Groen, *Het Wetenschappelijk Onderwijs in Nederland van 1815 tot 1980, een onderwijskundig overzicht; 1: De wetgeving* (Eindhoven, 1983) [*Eindhoven University of Technology Research Reports, Department of Philosophy and Social Sciences*, 83-WM-001], p. 27. *Privaatdocenten* were allowed to be named beginning in 1876.

2 Shigeru Nakayama, transl. Jerry Dusenbury, *Academic and Scientific Traditions in China, Japan, and the West* (1974; Tokyo, 1984), pp. 29-31, 115 on disciplines. Nakayama's brilliant treatise is a model of comparative reflection.

geology, much as they assimilated the best work of their disciplinary colleagues in Germany, Britain, and France. The Dutch surveyed the exact sciences from above and swept in to carry off the choicest scientific morsels. Fluent in German, English, and French, they were lords of the intellectual air and masters of natural law.

It is natural to ask how a portrait of the Dutch masters of nineteenth-century science would compare with tableaux of European cousins. Like Germany but unlike France and England, the Netherlands certified scientists by requiring facility in research. Similar to the French experience but unlike what was taking place in Germany or England, national educational authorities held engineering in high regard. As in a number of countries, university professors turned their talents to technological applications. The class image of science in the Netherlands came closest, nevertheless, to that in England, where sons of aristocrats, professionals, farmers, and entrepreneurs met on equal ground.

Studies of science and politics in Great Britain during the 1830s and early 1840s proclaim the central importance of the *class* called "gentleman" in understanding the evolution of scientific discourse. One author emphasizes that "for much of the nineteenth century the view of science as just another facet of the cultured gentleman's repertoire persisted." The "gentleman amateur," as the "hegemonic ideal of the British ruling class," is supposed to have undercut independent scientific development and especially professionalism.[3] According to the authors of another study, the

> gentlemen who chose science as a vocation committed their time and energy to a scientific career not for a livelihood but for a lifetime. They scorned any crass concern with formal qualifications or pecuniary reward, and resisted the encroachment of State bureaucracy on what was properly a private field of endeavour.[4]

Within their "vocation," however, these gentlemen of science were more than willing to scrap for possession of intangibles like priority of discovery and peer approbation. The authors emphasize the veniality of the gentlemen: "Precisely because they saw science as a matter of individual vocation, they were acutely conscious of their own career interests and intellectual property."[5] In a later place they remind the reader that gentlemen of science could be "stars, or lions, or the owners of valuable property" and that, like the avaricious and grasping mill owners whom they despised, the "gentlemen" would direct discussion at scientific meetings toward "deliberate display, calculated agression, or die-hard defense, depending on how

3 Morris Berman, "'Hegemony' and the Amateur Tradition in British Science," *Journal of Social History*, *8* (1975), 30-50, quotations on pp. 35, 40, 37 in sequence.

4 Jack Morrell and Arnold Thackray, *Gentlemen of Science: Early Years of the British Association for the Advancement of Science* (Oxford, 1981), p. 424.

5 *Ibid.*

deep were the intellectual and career interests at stake."[6] For still another author, "gentlemanly specialists" of this period, by virtue of the fact that they did not have to earn their living through their scientific "vocation," hardly inhabited an "imagined paradise of scientific harmony and cooperation. On the contrary, the very absence of narrowly professional rewards gave a sharp edge to their competitive building of less formal careers." The author continues, emphasizing the lack, for these gentlemanly specialists, of "a recognized ladder of advancement as the anticipated reward for mere diligence." This absence stimulated the gentlemen to struggle for recognition and priority; competition and controversy were for this reason "exposed with a clarity that has rarely been matched in later periods."[7]

These formulations raise more questions than they resolve. Given that the non-professional ideology of the British protagonists did not embrace the contemporaneous Germanic desire to follow a scientific "calling" in a state-supported institution of higher learning, why should the pastimes of wealthy men be designated as *vocational* rather than *avocational*? Why does it *necessarily* follow that the gentlemen of science gave vent to intense passions in pursuit of their avocation? Were these passions different from those of roués, snuff-box collectors, or pigeon fanciers? Did these passions, once awakened, completely consume the spirit, destroying gentlemanly poise and decorum on shooting parties and Derby days? Was their self-image in fact pure fraud and pretension? Did the gentlemanly specialists not look forward to honors and prizes, the very rewards sought later by aspiring Nobel laureates and Guggenheim fellows, no less than by provincially situated *scientifiques* and *Wissenschaftler*? Was not the diligence of the fact-compiler and prolific paper-writer rewarded by fellowship in one or another domestic society? And where were competition and controversy more evident than among the thousands of young German doctors of philosophy, clawing their way across the latter part of the nineteenth century into assistantships, lectureships, and a succession of chairs *without* the inconvenience of having to keep up appearances as a gentleman?

What was a gentleman? How was he to act? By the eighth edition of the *Encyclopaedia Britannica*, in 1856, the term gentleman was no longer restricted to someone "who without any title, bears a coat of arms, or whose ancestors have been freemen"; rather, the designation extended "to all persons above the rank of common tradesmen when their manners are indicative of a certain amount of refinement and intelligence."[8] Manners, such as knowing how to use cutlery properly and being able to quote a bit of French, seem to have formed the center of the matter. In a broader sense, as historian Hippolyte Adolphe Taine remarked, the gentlemanly

6 *Ibid.*, p. 460.

7 Martin J. S. Rudwick, *The Great Devonian Controversy: The Shaping of Scientific Knowledge among Gentlemanly Specialists* (Chicago, 1985), p. 18.

8 *Encyclopaedia Britannica*, eleventh edition (1911), "Gentleman," *s.v.*

ideal summarized the entire history of English society. It was based "not on observation but on rooted belief in a moral code, on the world of *ought*, not on the world of *is*." For Samuel Smiles, the nineteenth-century philosopher of 'self-help,' true gentlemen instinctively recognized each other; the thought never occurred to them that they might "use their power for unworthy aims," much less lose their self-control.[9] In the view of Asa Briggs, this vision was unique to Victorian Britain.[10] That the nineteenth-century British gentleman was by no means adverse to earning money has been emphasized by David Landes: "The concern of the British gentleman for the accretion of his fortune made him a participant in society rather than a parasite upon it—whatever judgement one may pass on the character of this participation."[11] And in his business interests, the British gentleman met people from all stations of life.

Whether or not science as a gentlemanly avocation is central to nineteenth-century Britain, it seems clear that the notion cannot serve in the Dutch context. Credentials and titles mattered for scientific luminaries in the Netherlands, who usually held forth from state-supported institutions. At the same time, men of learning depended on private and municipal initiative—the rise to prominence of the University of Amsterdam and the persistent endowment of science by the Teyler's Stichting in Haarlem being prime examples of the general point. In the world of science, grace and affable manners mattered less than what a researcher could produce.

The following pages shall show that Dutch gentlemen freely implicated themselves in the life of the exact sciences. Javan planters and physicians—from K. A. R. Bosscha and R. A. Kerkhoven to Denis Mulder and Agathe van der Plaats-Keyzer—erected and maintained private laboratories and observatories. Men of independent means who held no academic or government appointment—Elie van Rijckevorsel, Joan Voûte, and P. G. Meesters—travelled half way around the world to scan earth and sky. They burned with a desire to prosecute pure learning.

All nineteenth-century Dutch scientists were literally *heren van wetenschappen*—masters, lords, or gentlemen of science. The sense, however, is not one of leisured affluence, of fox-hunting across vast country estates; it is one of being in control of things. The special social compact of Dutch scientists, already evident in the middle of the nineteenth century, proved remarkably tenacious well into the twentieth. As British gentleman-amateurs gave way to university-certified professionals, as German engineers hammered for social parity with classically-trained university counterparts, as French academicians stumbled blindly into a system for apprising

9 Taine and Smiles quoted in Asa Briggs, *The Making of Modern England, 1783-1867: The Age of Improvement* (New York, 1965), p. 411.

10 *Ibid.*, p. 412.

11 David Landes, *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present* (Cambridge, 1969), p. 70.

students of research, the Dutch scientific community adapted easily and successfully to the technological and egalitarian age. This flexibility prefigured extraordinary intellectual accomplishments, and it permitted the academic community to take an active role in colonial affairs.

## The Background to a Colonial Scientific Culture

Chroniclers of natural history accompanied military conquerors and civilian administrators beginning with Dutch colonial expansion during the first half of the seventeenth century. Their reports appeared in the open intellectual climate of the golden age. Only with the last quarter of the eighteenth century, however, did scientific institutions come to Batavia, the commercial center of the principal overseas colony. The most tenacious of these institutions emerged in 1778 as a member (and not the least illustrious one) of the literary and philosophical societies that sprang up in provincial settings around the world. Polite discussion of antiquities, curiosities, and natural phenomena taking place in the rooms of the Bataviaasch Genootschap van Kunsten en Wetenschappen matched rhetoric reverberating from sister societies in Philadelphia and Manchester, and from the Genootschap's spiritual mother, the Hollandsche Maatschappij der Wetenschappen in Haarlem.[12]

After it received new life from Thomas Stamford Raffles during the British interregnum, the Bataviaasch Genootschap progressively evolved into a society for Indological debate—both archaeological and ethnographical. The Genootschap did inaugurate a museum of natural history in 1835, but its publications could not accommodate the spirit of scientific research which, by the 1840s, had spread to Batavia. New periodicals and assemblies came to fill the void. Inspired by having participated in several of these informal enterprises, the sometime librarian of the Bataviaasch Genootschap—himself an avid naturalist—brought into being the Royal Scientific Association, the Koninklijke Natuurkundige Vereeniging in Nederlandsch Indië (KNV), in 1850. The founder, Pieter Bleeker, then set up a companion association in medicine. The KNV became the principal, omnibus scientific society in the Netherlands Indies, and its journal the colony's favored publishing outlet.[13] From its founding until 1864 the association received an annual government grant of *f* 4000; it received half that sum each year between 1864 and 1925.[14]

12 Among recent publications: Dirk J. Struik, *Het Land van Stevin en Huygens* (1958; Nijmegen, 1979), pp. 132-8; Van Berkel, *Voetspoor van Stevin* [note 1], pp. 208-13; H. A. M. Snelders, "Het Bataviaasch Genootschap van Kunsten en Wetenschappen in de periode 1778-1816," *Documentatieblad Werkgroep 18e eeuw*, nos. 41-42 (1979), 62-90.

13 P. J. Willekes Macdonald, "De Koninklijke Natuurkundige Vereeniging in Nederlands-Indië," in *Eeuw*, pp. 3-21. H. C. D. de Wit, "De KNV en de botanie in Indië," in *Eeuw*, pp. 153-77.

14 BAN, BGS, 16 Oct 1937, N° 2240/B. Director of Finances to Governor General, 1 Sep 1937, where the history of funding for the KNV is provided.

The renewed interest in learning followed a major restructuring of the colonial economy. During the fifteen years of the unified kingdom, from 1815 to 1830, the Netherlands had continued to administer its Asian colonies in the manner of its old East India Company: The colonial power took its due in taxes calculated as two-fifths of the local crop, usually rice. The system discouraged expansion of export crops and deterred agricultural innovation; because of a shortage of circulating currency, in some cases the tax could not even be collected. With the secession of Belgium in 1831, Holland lost its manufacturing base, and the expense of maintaining colonies threatened to reduce the small and prosperous European country to the level of a poverty-stricken Portugal. The genius of Johannes van den Bosch, however, appointed governor general in 1830 and afterwards colonial minister, provided Holland with a new lease on life as a colonial power. Van den Bosch conceived of the *cultuurstelsel*, a form of agricultural taxation that has passed into English as the 'culture system.' According to this regime, a peasant could achieve remission on his taxes by growing government-owned export crops on one-fifth of his land. The regime, largely confined to Java, had the effect of introducing compulsory labor and of transforming the central island of the Indies into an enormous government plantation. The culture system cohered with the Dutch philosophy of dual control: Local regents would police the lands, while Dutch residents would extract material wealth.[15]

The culture system succeeded beyond the wildest dreams of even Van den Bosch: Between 1830 and 1840, exports from the Indies rose from *f* 12.9 million to *f* 74.2 million. By 1840, Java was the milch-cow that kept Holland solvent. But the system exacted a terrible price. It encouraged export cultivation to the exclusion of locally consumed foodstuffs. The Dutch residents consolidated their power as the regents assented to the new regime. With Van den Bosch's administrative system providing ready access to free labor, a network of roads penetrated into the Javan countryside at the same time that starvation became increasingly common.

A decline in the profitability of a system that produced fabulous wealth is readily understood from the economic point of view. To substitute a plantation economy for one based on primitive accumulation or extraction requires much planning. The 1860s saw a liquidity crisis, as bimetalism restricted the monetary supply and as a single Dutch trading company, the Nederlandsche Handelsmaatschappij, came to dominate export channels. Between 1848 and 1870, the colonial ministry squeezed the Javan economy as hard as it could—although the overlords had few models to emulate in this regard. Uncertain about the proper direction to take, the

15 M. C. Ricklefs, *A History of Modern Indonesia* (London, 1981), pp. 114-42. A standard source is J. S. Furnivall, *Netherlands India: A Study of Plural Economy* (Cambridge, 1939, 1967). A comparative perspective is provided by H. L. Wesseling, "Les Transformations du 'world-system' à la fin du dix-neuvième siècle et l'empire colonial néerlandais," *Europa: A Journal of Interdisciplinary Studies* (Montreal), *1*, 1 (1977), 37-49.

regime launched into conflicting policies. It pushed ahead to transform Java into a vast tea and sugar plantation, undertaking ambitious irrigation projects to encourage *saweh* (paddy) production of rice. At the same time, it pondered the underexploited Outer Possessions—the islands beyond Java which were the principal source of spices and pepper—and considered how best to profit from the *swidden* (slash-and-burn) mode of cultivation there. An informed decision required precise knowledge of topography and climate. We shall see that this is the reason for the appearance of astronomers and physicists in the Malay archipelago.

In the period before around 1870, the masters of science in the Indies remained uncertain if they would concentrate on a broad survey of the entire archipelago or a detailed account of Java. That they came to focus on institutions in the neighborhood of Batavia is explained by the government's inward gaze. It neglected the Outer Possessions largely because its political base and economic infrastructure were most secure on a number of the smaller, central islands. This 'involutive' policy, to use a term from Clifford Geertz's study of swidden and saweh in Indonesia, is the expected outcome for a central regime finding its autocratic powers eroding.[16] During the early years of the restoration, from 1815 to 1848, the king of the Netherlands had complete control over the colonies; he appointed whom he liked as governor general, and he needed to keep no accounting of expenses or profits. Beginning with the liberal constitution of 1848, the king had to report yearly to the Dutch second chamber, the parliament, through the person of the colonial minister. By 1864 the parliament had won direct control over the colonies.[17] Political wrangling in the Netherlands had an impact on Indian policies whenever the colonies threatened to cease channeling wealth to the docks and counting houses of Rotterdam and Amsterdam. With colonial exploitation under increasingly unsympathetic scrutiny, the colonial ministry could hardly have been expected to champion innovative new projects, such as an expensive administration in the Outer Possessions.

By 1870, coffee and sugar had risen to account for 88% of Indonesian exports, up from 49% in 1830.[18] The plantation economy had been pioneered by the government. With parliamentary control of the Indies came, in 1867, the liberal ascendency, a laissez-faire environment that lasted for the rest of the century. The government progressively divested itself of land management and cultivation. The triumph of liberal economy in the case of the Indies, however, was a result of technological change and industrial development in which the Netherlands did not actively participate. The opening of the Suez canal in 1869 provided new markets

16 Clifford Geertz, *Agricultural Involution: The Process of Ecological Change in Indonesia* (Berkeley, 1963).

17 Bernard H. M. Vlekke, *Nusantara: A History of the East Indian Archipelago* (Cambridge, Mass., 1943), p. 283.

18 Geertz, *Involution* [note 16], p. 55.

for coffee, sugar, tobacco, and tea. With the Javan administrative infrastructure secure, commercial investors took out long-term leases on government lands and made enormous profits. The profits continued across the long, great depression as, with a steady rise in standards of living throughout the industrialized world, wage-earners and shop-keepers gave in to a desire for ingestible stimulants. The Dutch East Indies provided one of the world's principal sources of civilized narcotics just at the time that the second industrial revolution unloaded tensions, anxieties, and psychoses on Europe and North America. Holland was Hebe at the banquet of Germany's Zeus and Britain's Poseidon.[19]

## Shadows: Projection and Adaptation

Those who supervised the extraction of natural resources for satisfying the addictions of the industrialized world, subsequently set up institutions shadowing metropolitan models. With the government's policy of involution, Batavia became the uncontested center of commercial and intellectual life for the colonial overlords, who progressively sought to ornament it with the appurtenances of high culture. A continuing chronicle of the colonial environment appeared in the KNV's *Natuurkundig Tijdschrift voor Nederlandsch-Indië* and other publications, and the reporting is decidedly impractical. In their search for understanding, the intellectual elite of the colony followed their countrymen at home. Knowledge of nature circulated in drawing rooms, rather than in mechanical workshops or specialist gatherings. Disciplinary societies in the Netherlands were a *fin-de-siècle* phenomenon, and mid-century scientificity required synthesizing specialized findings before an audience of polymaths and generalists.[20]

The dominant scientific interests in nineteenth-century Indonesia related to geographical botany and ethnology. There were great rewards for cultivating useful plants, just as control of an island civilization could be held to depend on understanding its customs.[21] The premier research institution in the East Indies at this time was the botanical garden at Buitenzorg, founded by the colonial government in 1817, and botanists naturally dominated the KNV. Impetus for exploration came from scientists who had the sense to establish supporting structures in the metropolis.

19 It is not my intent to enter the current debate on the particular form of late nineteenth-century expansion in the East Indies. A survey may be found in: J. Th. Lindblad, "Economische Aspecten van de Nederlandse expansie in de Indonesische archipel ten tijde van het moderne imperialisme (1870-1914)," in *Imperialisme in de marge: De afronding van Nederlands-Indië*, ed. J. van Goor (Utrecht, 1986), pp. 227-65.

20 For example, the *Voordrachten* series of the Koninklijke Natuurkundige Vereeniging, inaugurated in 1889 for the Dutch neohegelian philosopher G. J. P. J. Bolland (at the time an English teacher in Batavia) and progressively abandoned in the twentieth century. Bolland, *De Ruimtevoorstellingen* (Batavia, 1889) [*Voordrachten*, N° 1].

21 De Wit in *Eeuw* for the botanical interest; Roy F. Ellen, "The Development of Anthropology and Colonial Policy in the Netherlands, 1800-1960," *Journal of the History of the Behavioral Sciences*, *12* (1976), 303-24, which, however, is broader than its title indicates.

The first of these was the Natuurkundige Commissie voor Nederlandsch-Indië, established by royal decree in 1820 and disbanded in 1850. The negotiations among scientists and administrators regarding establishment of the magnetical and meteorological observatory in Batavia, an institution that had close ties to the Humboldtian notion of natural history, are broadly illustrative of the general pattern.[22] Other metropolitan institutions—notably the Koninklijk Nederlandsch Aardrijkskundig Genootschap and the Koninklijk Instituut voor Taal-, Land- en Volkenkunde—funded expeditions over the next generation. This was not enough for Melchior Treub, director of the Buitenzorg gardens.[23]

On leave in the Netherlands in 1887, Treub brought about a Commission for the Advancement of Scientific Research in the Dutch Colonies. The commission, funded privately to set a research agenda, included 30 Dutch members and 15 members from the East Indies. Returning to the Indies, Treub set up an Indian Committee for the Advancement of Scientific Research in the Dutch Colonies. The Indian Committee drew from members of the Bataviaasch Genootschap, the KNV, and the local medical association; it was a branch of the Dutch Commission, and it obtained funds from the Dutch Geographical Society. Commission and Committee led, in 1890, to a Society for the Advancement of Scientific Research in the Dutch Colonies. In the period before the First World War, the Society organized a number of successful explorations. With enormous sums of money flowing between the mother society and its Indonesian daughter—the Society provided an annual subsidy of *f* 10,000 to the Indian Committee—it became important for the offspring to be given legal, corporate status. This happened in 1897, and the daughter then took the name of Indian Committee for Scientific Research (ICWO). With new funding from the colonial government, the ICWO began directing a number of projects. In an attempt to regain control, especially over the government subsidy that by 1912-16 amounted to *f* 30,000, the metropolitan stewards (Society, Commission, and governing council or Committee, along with the Geographical Society) consolidated forces. The ICWO, however, declared itself to be nothing less than an equal partner, or "sister institution," and in 1920 it received modified statutes from the government to this effect.[24]

At the time that the ICWO was emerging as a dominant force in natural history and geographical exploration, other scientific specialties grew to maturity. The magnetical and meteorological observatory, early in the twentieth century, represented the leading edge of a transformation in the

22 The matter is considered in chapter three.

23 H. H. Zeijlstra Fzn, *Melchior Treub: Pioneer of a New Era in the History of the Malay Archipelago* (Amsterdam, 1959).

24 Chronology and identifications are taken from Jan H. Kompagnie, *Inventaris van de archieven van het Indisch Comité voor Wetenschappelijke Onderzoekingen (1888-1941), de Natuurwetenschappelijke Raad van Nederlandsch-Indië (1925-1941) en de Coördinatie Commissie voor Natuurwetenschappelijke Zaken (1945-1948)* (The Hague, 1982) [Algemeen Rijksarchief, Tweede Afdeling]. See also Zeijlstra, *Treub* [note 23], pp. 58, 67-9.

scientific infrastructure of Indonesia. New institutions of higher learning emerged over the next decades. Foremost among these were an astronomical observatory at Lembang and an institute of technology at nearby Bandung, both initially funded by private sources and both taken over shortly thereafter by the colonial government. A medical school at Batavia rose, late in the 1920s, to become a university-level faculty. All three institutions hosted research in the exact sciences.

Scientific proliferation produced, in the years around 1900, a struggle for hegemony. Treub precipitated extraordinary debate in 1902 with a plan to create a colonial departement for scientific research along the lines of the United States Department of Agriculture, with the botanical gardens as its centerpiece. The botanist wanted to absorb, for his departement, nearly all the research institutions already in place, including those of the mining and forestry services, the Batavia medical school, and the navy's magnetical and meteorological observatory. The plans provoked energetic denunciations from Treub's scientist colleagues, who feared becoming subordinate to a czar of practical results. The directors of the medical laboratory and the observatory at Batavia both successfully defended the independent scientific character of their institution. Neither of the two operations ornamented the departement of agriculture when, in 1904, Treub became its first director.[25]

A second attempt to persuade the colonial government to endow a central scientific authority occurred in 1913. The man behind it was Jacob Christiaan Koningsberger, a zoologist by training who, as Treub's protégé, had been passed over to succeed his patron at the head of the departement of agriculture.[26] From his post as director of the Buitenzorg botanical gardens, Koningsberger called for creation of a colonial version of the Amsterdam Academy of Sciences. He proposed a Central Scientific Institute for the Netherlands East Indies to coordinate and encourage research, provide liason between colonial scientists and their metropolitan colleagues, and offer advice to the colonial government. The institute would be responsible not to a departement but rather to the government's general secretariat.

The directors of the agriculture and education departements found merit in the proposal, so the governor general went to the Netherlands for an opinion from the newly formed Colonial Institute, a metropolitan organization intended to supervise several institutions in trade, ethnology, and tropical hygiene.[27] The result was a devastating criticism of Konings-

25 Zeijlstra, *Treub* [note 23], pp. 86-100, where the objections of observatory director Simeon Figee and laboratory director J. de Haan are extracted.

26 On Koningsberger: K. W. Dammerman, "Zoölogisch Onderzoek," in *Eeuw*, pp. 178-86, on pp. 179-80; Zeijlstra, *Treub* [note 23], pp. 8, 102-4, 106.

27 On the Colonial Institute, see the contributions by W. L. Utermark, L. G. Felhoen Kraal, and E. P. Snijders in *Report of the Scientific Work Done in the Netherlands on Behalf of the Dutch Overseas Territories during the Period between approximately 1918 and 1943*, ed. Bertram Johannes Otto Schrieke (Amsterdam, 1948), pp. 274-300, esp. pp. 274, 295-7.

berger's attempt to free colonial science from metropolitan authority. The Colonial Institute, in its brief to the governor general, felt that the East Indies did not require a lower-case academy of sciences, which would be "nothing less than a source of jealousy, personal sensitivity, and everything fatal stemming therefrom." Koningsberger's "declared aims" were "to supply scientific information to the government and to confer scientific distinction on chosen individuals." His was an odious formulation: "These aims have proved to be more superfluous and burdensome than advantageous."[28]

In replying to the strictures of the Colonial Institute, Koningsberger first discredited the authority of the critic. The metropolitan institute claimed to be active in only three areas—a commerce museum, ethnology, and tropical hygiene—among the many fields to be included in a central scientific institute for the Indies. Koningsberger emphasized that though many scientific institutions fell under the control of one or another departement, nothing existed in the way of a central adminstrative structure for "purely scientific work." The time had come, furthermore, to recognize scientific achievement among colonial researchers, whether or not individual egos would as a result be hurt. In conclusion, he repeated what he had written in his original proposal: "The days are gone when, in the Indies, to bring energy and resources to the field of research, little or nothing can be undertaken or executed without the patronage of the fatherland." This patronage would not easily be abandoned, but to invoke the authority of the Colonial Institute in the present case seemed to Koningsberger not unlike giving the power of "veto" to a young institution that had yet to prove itself.[29] The metropolitan veto held sway over colonial minds.

In the BAN, Indonesian authorities have kept the archives of the Algemeene Secretarie in essentially their state of 1949; documents and dossiers are classified in the manner of a working bureaucracy. Files from the more distant past are found readdressed to reflect subsequent concerns. In principle, if the files concerning a particular *besluit* were assigned a new address, the transfer is noted at the old address, in a relevant *klapper*, and in a master card file; in practice, it is often impossible to retrieve files indexed in a thematic *klapper*. The documents *circa* 1913 concerning the Centraal Wetenschappelijk Instituut voor Nederlandsch-Oost-Indië and those *circa* 1928 concerning the Natuurwetenschappelijke Raad van Nederlandsch-Indië (NWR) are found filed with Bt 31 May 1928, N° 14, to which location has been reassigned the material related to Bt 22 Dec 1913, N° 19. Koningsberger, "Nota betreffende de oprichting van een centraal wetenschappelijk instituut voor Nederlandsch Oost-Indië," 12 Feb 1913; Director of Education and Spiritual Affairs to Governor General, 29 Mar 1913; Director of Agriculture, Health, and Commerce to Governor General, 11 Mar 1913.

28 *Ibid.* Vereeniging 'Koloniaal Instituut' to Minister of Colonies, 16 Jun 1913.

29 *Ibid.* Koningsberger to Director of Agriculture, Health, and Commerce, 21 Aug 1913. My discussion of the evolution of the Natuurwetenschappelijke Raad and related institutions departs from the remarks by G. van Iterson, Jr, as translated by John B. A. Nijssen, in *The Netherlands East Indies and the Royal Netherlands Academy of Sciences and Literature* (Amsterdam, 1946). Compare p. 28, where Van Iterson refers to 1915 as the date of an early plan for a "Central Science Institute." Compare also the chronology and rhetoric of Van Iterson, Ph. S. van Ronkel, and W. H. Rassers in *Report* [note 27], pp. 301-10, esp. pp. 306-7.

Five years after Koningsberger tabled his proposal, the Batavia observatory's director Willem van Bemmelen used the KNV—an association essentially restricted to Batavia in which he played a dominant role—to establish the mechanism for a broad-based, regular, scientific congress at which all researchers would be welcome. After corresponding with 36 separate colonial research institutions, Van Bemmelen set up a council to prepare for the first Netherlands Indies Scientific Congress. The accent, he emphasized at an organizing meeting held in 1918, was on "purely scientific work." Van Bemmelen succeeded in becoming the vice-president of the congress's governing council, the presidential role falling to Koningsberger. When Koningsberger returned to the Netherlands shortly before the first gathering, Van Bemmelen ascended to the presidency.[30]

Through the congress's ruling council, Van Bemmelen once more called upon the government to endow a central scientific authority. In their published appeal, the council described an elite organization that would supervise the development of new areas of science, including the appointment of professors in the institutions of higher learning that were being erected. The new authority would act to mediate between competing or complementary researchers. It would supervise the publication and dissemination of research results. The appeal was discussed in August 1919 by representatives from the KNV, the ICWO, the Netherlands Indies branch of the Royal Institute of Engineers, the Association of Civil Servants in Forestry, and the Association for the Advancement of Medical Sciences in the Netherlands Indies. They resolved to erect a provisional central authority from members of the ten most important scientific bodies in the colony. The task of the provisional authority would be to advance the question of a permanent, government-funded successor.[31]

Because Koningsberger had modeled his proposal of 1913 on the Amsterdam Academy of Sciences, subsequent discussion about a central scientific body generally took the proposal as a fundamental document. Such a formulation carried the probability of eventually eliciting a sympathetic echo from the parent body. The echo came in 1924, in a royal *besluit* restating the academy's operation. For the first time corresponding members of the academy in the Indies obtained the implicit privilege of organizing themselves into a body for advancing the cause of science.[32] As the colonial academicians were eager to charter what seemed to have been

30 The inception of the Netherlands Indies Scientific Congresses is chronicled in *1° NINC Hand.* (1920), pp. vii-ix, (1)-(44).

31 *1° NINC Hand.* (1920), pp. (34)-(39).

32 BAN, BGS 8 Nov 1927, N° 736 B. Director of Agriculture, Health, and Commerce to Governor General, 21 Feb 1927, citing the royal *besluit* of 13 Mar 1924. Compare Van Iterson, *Netherlands East Indies* [note 29], pp. 9, 12: "In the new Regulations—which were laid down in the Order in Council of March 13th, 1924—the words [of 1855] '[the Academy was meant to be a center of cooperation for the scholars in the Netherlands and] Overseas Possessions of the Empire' were changed at the suggestion of the Academy, the term being old-fashioned. The article was then made to read: '. . . a centre of co-operation of scientists in the Netherlands, the Netherlands East Indies, Surinam and Curaçao.' "

granted in the motherland, the colonial government sought to domesticate the central body by shearing it of latitude and independence.

The delicate task fell to the director of agriculture, health, and commerce, Abraham Arnold Lodewijk Rutgers, who was himself a botanist. The routine title of his departement obscures the fact that it financed the majority of colonial scientific institutions—a circumstance reflecting its origin under Melchior Treub.[33] In a letter to the governor general, Rutgers set down the evolution of plans for the central scientific body. He agreed that science in the Indies was reaching toward a state of "independence and autonomy." The KNV, he noted, had served as a scientific advisory board in the nineteenth century, but over the preceding twenty-five years it declined in this role because of a number of circumstances. First, scientific specialization had bypassed the KNV; second, the government had become involved in science through its own laboratories and services; third, science was no longer centered around Batavia. The new central scientific body had to limit itself to the natural sciences. The letters section of the Amsterdam academy already had a parallel in the old Bataviaasch Genootschap.[34]

In his long submission to the governor general, Director Rutgers reported that he had convened a broad assembly of scientists to discuss the matter, and they agreed with him. The assembly named Rutgers, a Bandung physician, and Bandung physics professor Jacob Clay to draw up concrete plans. The resulting proposal was neither an institute nor an academy, but a *raad*, or council. Its mandate comprised providing advice to the government, acting as a focal point for science in the Indies, serving as a liaison between colonial and foreign scientists, and generally advancing the cause of research. There were two reasons for this formulation: First, all the existing scientific associations could live with it; second, a broad-spectrum disputational society was inappropriate for advancing the specialized nature of science, which required specialist associations.[35] The director of the departement of education and spiritual affairs supported the proposal, even though he wondered about overlap between the council and the Bataviaasch Genootschap.[36]

Members of a scientific community often seek to establish a central authority in order to exclude competitors from access to sources of funding. Although this strategy figured in planning for a central scientific advisory body, the evidence lends support to the forthright arguments of Koningsberger, Van Bemmelen, and other colonial statesmen of science.

33 P. Kleintjes, *Staatsinstellingen van Nederlandsch-Indië*, 2 vols (Amsterdam, 1927-29), *1*, 280-1. Agriculture remained a separate departement until 1911, when it assumed the health portfolio from education and spiritual affairs, and when its third charge became commerce.

34 BAN, BGS 8 Nov 1927, N° 736 B. Director of Agriculture, Health, and Commerce to Governor General, 21 Feb 1927.

35 *Ibid.*

36 BAN, BGS 8 Nov 1927, N° 736 B. Director of Education and Spiritual Affairs, "Beschouwingen en Raad," 8 Mar 1927.

Between the world wars, research scientists indeed found themselves at an organizational disadvantage when compared with colleagues in other intellectual pursuits. In 1925, for example, the KNV found its annual subsidy halved, from *f* 2000 to *f* 1000; this was about the amount granted the ICWO and also the amount subsidizing the *Annales* of the Buitenzorg botanical gardens. The Nederlandsch Bijbelgenootschap received an order of magnitude more funding, and the Bataviaasch Genootschap fifty times as much.[37]

In following a policy that the Dutch governments applied to many new projects in science, the colonial regime did not intervene until private initiative had demonstrated the feasibility of the proposed structure, in this case by running scientific congresses and a shadow central scientific body for nearly a decade. The colonial regime finally created, in 1928, the Scientific Council of the Netherlands Indies (NWR) as a broad-based advisory and administrative board. It is not surprising that the NWR followed Koningsberger's model, for in 1926 Koningsberger had become colonial minister in The Hague.[38] Members of the *raad* came from the set of correspondents of the scientific section of the Amsterdam Academy of Sciences. By the nature of its engagements, however, the NWR evolved into something both more and less than the government had envisioned. On the credit side of the ledger, membership on the council provided recognition for colonials who lacked credentials as researchers, and in this way it functioned as an academy *manquée*. On the debit side, the NWR, with a mandate to coordinate the activity of isolated researchers, focused on little more than assembling scientists for conferences—a function that the scientific community had obviously acquitted itself of for nearly a decade.[39]

The most significant international gathering in the East Indies during the interwar period was the Fourth Pacific Science Congress, held at Batavia in 1929. Planning for it took four years. The initial estimates, prepared for the third congress held at Tokyo in 1926, projected 150 participants whose care would cost *f* 125,000; the organizing committee alone would cost *f* 29,000. The NWR absorbed this expensive and prestigious activity, an imposition wisely unopposed by the Pacific Science Congress organizers.[40] The Great Depression determined that the *raad*

37 BAN, BGS, 16 Oct 1937, N° 2240/B. Finance Director to Governor General, 1 Sep 1937. KNV funding from the 1920s and 1930s, other institutions from the late 1930s.

38 Kleintjes, *Staatsinstellingen* [note 33], *1*, 384.

39 Kompagnie, *Inventaris* [note 24], p. vi. Compare the opinion of Van Iterson, *Netherlands East Indies* [note 29], p. 28, where the NWR is said to have stemmed from an initiative by the Amsterdam academy.

40 BAN, Tzg. Ag. N° 19044/1935. Secretary of the Natural Sciences Section of the Amsterdam Academy to Minister of Education, Art, and Science in The Hague, 24 Jul 1925, in support of holding the Fourth Pacific Science Congress on Java. "Raming van kosten, verbonden aan een officieële ontvangst van de leden van het 4° Pan Pacific Science Congress te Batavia in 1929," [1926], for funding estimates. Bt 18 Aug 1928, N° 21, for a grant of *f* 25,000 to the organizing committee. BAN, BGS, 8 Nov 1927, N° 736 B, Director of Agriculture, Health, and Commerce to

would preside over fourteen difficult years of eroding fortunes and retrenched scientific activity.

## Western Science Embedded

The colonial scientists did more than organize conferences. They published detailed proceedings, including questions and debates from the floor, in the model of the Swiss, British, and German associations for the advancement of science. This circumstance broadened the already wide range of outlets open to both professional and amateur researchers. Many laboratories and observatories—such as government tea-research stations, the Batavia observatory, and the astronomical observatory at Lembang—had their own *verhandelingen* or occasional papers series. The *Natuurkundig Tijdschrift voor Nederlandsch-Indië*, having been published continuously for over two generations, remained a reliable means of appearing in print quickly; it found a companion in the local medical association's *Geneeskundig Tijdschrift*. Just as in the Netherlands, professors often circulated their inaugural or valedictory addresses as privately printed monographs, generally issued by Indonesian publishers; less distinguished researchers printed their thoughts for no special occasion.

Preventing this world of paper from moldering in the tropics was the practice, common then as now, of republishing communications at more prestigious or accessible addresses. The Amsterdam Academy of Sciences, for example, did not mind serving in this role, provided that one of its number could be found to accept responsibility for the duplication by 'presenting' it. Foreign scientists had every opportunity of following the discoveries of their colleagues in Indonesia. The record suggests that they did not do so due to ignorance and prejudice.[41] If colonial scientific institutions shadowed Dutch masters, colonial scientific publications were overshadowed once by journals in the metropolis and a second time by the nearsightedness of English and German competitors.

As the colonial shadow players projected themselves with strong voices, they departed from European scripts. Unlike the case in the motherland, where funding for science came largely from government or academy coffers, entrepreneurs and businessmen underwrote scientific life. Money for expeditions and equipment funneled into Indonesian bank accounts from paper organizations in Amsterdam; wealthy plantation owners contributed enormous sums for the physics laboratory at the Bandung Insti-

Governor General, 21 Feb 1927, for acquiescence by the organizing committee to the authority of the NWR

41 The relative invisibility of the Indonesian research community in exact sciences which is recorded in Henry Small's *Physics Citation Index 1920-1929* (2 vols [Philadelphia, 1981]) seems to be in part an artifact of his choice of periodicals. The set of source journals generally excludes academy and society proceedings; *Physica* is the only Dutch journal present. Lewis Pyenson and Milan Singh, "Physics on the Periphery: A World Survey, 1920-1929," *Scientometrics*, 6 (1984), 279-306.

tute of Technology and the astronomical observatory at nearby Lembang. In the Netherlands institutional loyalty and pride of place were factors in making career choices. Not so in the colonies. There, scientists saw employment as a situation to be exploited with a view toward receiving a European call.

The following pages examine master and shadow at observatories and laboratories in astronomy, physics, and geophysics. Whatever nuances may be ascribed to cultural imperialism, it is a process exhibited in action as well as in word, in patterns of activity as well as in rarified discourse. For this reason, scientists form the center of the narrative. In their aspirations, accomplishments, and failures may be read the texture of imperialist incursion as well as the harmonies of pure learning. The interaction between scientists, colonial administrators, ministers of state, and private philanthropists is especially important. Visions of empire are best delineated by concrete example, rather than pious sermon.

The past decade has witnessed growing interest in the relationship between scientific activity and imperial design. Whether through unavailability of resources or hazard of imagination, the focus has been on the English-speaking colonies, dominions, territories, and satrapies.[42] The Dutch East Indies provide an indispensable corrective to Anglocentric myopia. What happened in Indonesia is also of intrinsic interest. A scientific society flourished at Batavia when Toronto was a collection of homesteads and cabins. Scientific doctorates were earned on Java before they made an appearance in Australia. The East Indies preceded Japan, Argentina, Canada, Tunisia, and India in providing a research laboratory to a future Nobel laureate. Physicists at Bandung succeeded in carrying out delicate measurements that for years confounded competitors at Pasadena and Chicago. The development of exact sciences in Indonesia, revealing an essential side to the ways and means of cultural imperialism, speaks directly to the advancement of human knowledge.

42 For example, the majority of contributions in *Scientific Colonialism: A Cross-Cultural Comparison*, eds Nathan Reingold and Marc Rothenberg (Washington, 1987). See, however, Nakayama, *Academic and Scientific Traditions* [note 2], esp. pp. 217-18, for a less provincial vision.

# 2

# Stars of the Southern Heavens

The skies over the Malay archipelago first received attention from Europeans through the publication of a star catalogue by Frederick de Houtman, a high official in the Dutch East India Company and later governor of the island of Amboina. In his catalogue, published in 1603, De Houtman listed 303 southern stars and included names for the major constellations provided by Petrus Plancius. Serious astronomy had to wait, though, for the appearance of Pastor Johan Mauritz Mohr, a native of Eppingen in the Pfaltz who studied theology at the University of Groningen and then, from 1737 to 1775, led the congregation of the so-called Portuguese Church at Batavia. A correspondent of metropolitan scientists as well as an eclectic observer of nature in the tropics, Mohr sent reports to the Hollandsche Maatschappij der Wetenschappen in Haarlem, which counted him as a member. Mohr's marriage provided the funds to equip a fine observatory, constructed in 1768. He observed the two transits of Venus across the sun in the 1760s, for Batavia lay in the path of both celestial events. The latter transit brought British and French expeditions to visit him. His appointment came from the Dutch East India Company, and he belonged to a tradition of amateur scientific activity then common among Protestant clergy. When Mohr died, his astronomical work found no successor. Astronomy in the East Indies had to wait three generations before being taken up again—under new political and economic circumstances.[1]

The circumstances, as we have seen, concerned both the Indies and the Netherlands. The universities of Leiden, Groningen, and Utrecht became infected with the research ethic. As the Dutch government made new overseas commitments, astronomers at each of the universities undertook research programs related to distant locations. Leiden contains the oldest, continually operating university observatory in Europe; in the nineteenth century, it effectively functioned as the Dutch naval observatory by training officers and calibrating instruments. Paid by the interior ministry, Leiden

1 Antonie Pannekoek, "Astronomy," in *Science in the Netherlands East Indies*, ed. L. M. R. Rutten (Amsterdam, [1929]), pp. 126-32, on p. 126; Harry Woolf, *The Transits of Venus: A Study of Eighteenth Century Science* (Princeton, 1959). According to Jean G. Taylor, *The Social World of Batavia: European and Eurasian in Dutch Asia* (Madison, 1983), p. 80, Mohr was first rector of the theological seminary at Batavia. Dutch astronomers *ca.* 1600 are ably studied by Elly Dekker in "Early Explorations of the Southern Celestial Sky," *Annals of Science*, *44* (1987), 439-70. A general survey has recently been provided by David S. Evans, "Astronomical Institutions in the Southern Hemisphere," in *Astrophysics and Twentieth Century Astronomy to 1950*, ed. Owen Gingerich (Cambridge, 1984) [*General History of Astronomy*, ed. Michael Hoskin, *4*, part A], pp. 153-165; it is irrelevant to the undertaking in the following pages.

astronomers travelled to colonial and foreign locations on major expeditions. Later in the century, Jacobus Cornelius Kapteyn, turned Groningen's poverty to virtue by analyzing photographical plates taken by David Gill at Cape Town, South Africa. In a decades-long cooperative arrangement, Kapteyn established a prototype 'laboratory' for measuring and analyzing stellar positions. Among all nineteenth-century Dutch astronomers, however, J. A. C. Oudemans at Utrecht enjoyed the most success in turning colonial ambitions to finance pure learning. The history of his observatory on the 'Sonnenborgh' is, more than any other European homologue, written in the enormous quantities of tea, sugar, coffee, and tobacco that funnelled from colonial plantations through metropolitan ports. As we shall see, the roots of Dutch excellence in astronomy are intertwined with the colonial ambitions of statesmen and politicians both in the Netherlands and on Java.

## The Dutch Background to Colonial Astronomy

The second great astronomer of the Dutch East Indies, Jean Abraham Chrétien Oudemans, was born in Amsterdam in 1827. His educator father, Anthonie Cornelis Oudemans, witnessed the scientific careers of three of his sons: Corneille Antoine Jean Abram, doctor of medicine, botany, and mycology at the University of Amsterdam; Antoine Corneille, chemist and director of the Delft Institute of Technology; and Jean Abraham Chrétien, astronomer. The young Oudemanses received early education in Weltevreden, the suburb of Batavia, where between 1834 and 1840 their father was principal of an elementary school; all went through secondary education in the Netherlands following their father's return to Leiden, a fortunate move so far as they were concerned, for the first *gymnasium* came to the East Indies only in 1860.[2] Anthonie Cornelis Oudemans was in a good position to help the careers of his sons, as he counted among his friends a number of English academics and clergymen. When Astronomer Royal George Biddell Airy visited Leiden around 1850, for example, he stayed with the elder Oudemans. J. A. C. Oudemans, indeed, credited his father with awakening his interest in science.[3]

At the age of sixteen Oudemans enrolled as a student at the University of Leiden, where he attended the lectures of Frederik Kaiser. These convinced him to specialize in astronomy. Oudemans grew close to his professor, and Kaiser tried to engage the neophyte at the observatory as an assistant. Oudemans, however, had other intentions, and at the age of nineteen he began teaching mathematics at a Leiden *gymnasium*. He remained there, as a bachelor, for seven years. He frequented the observa-

2 In *Encyc.*, *s. v.*: "Oudemans" and "Onderwijs."

3 USS. Airy to Oudemans, 4 Jul 1854; D. H. Flower to Oudemans, n.d. J. A. C. Oudemans, *Afscheidsrede, gehouden in de gehoorzaal der Rijks-Universiteit te Utrecht den 9en juni 1898, des morgens te 11 ure* (Utrecht, 1898), p. 9.

tory during his teaching years. The culmination of his efforts came in 1852 with a doctoral dissertation on the determination of the latitude of Leiden; the following year he became Kaiser's permanent assistant. From 1853 to 1856 Oudemans dedicated himself to observing asteroids and variable stars, publishing several papers. He also kept his eyes open for academic appointments at home and abroad, investigating, among other possibilities, a chair at the new University of Melbourne in Australia.[4]

Oudemans's patron Kaiser had been appointed director of the Leiden observatory in 1837. His background and career trajectory resembled those of his student. Kaiser's father, a German teacher, died when Kaiser was eight. He became the ward and pupil of a talented uncle, Jan Frederik Keyser, who was a member of the Amsterdam Academy of Sciences and professor of mathematics and astronomy. Profiting from this tutelage, Kaiser published his first scientific paper, a calculation of the lunar occultation of the Pleiades, at age fourteen. Kaiser found his way to the Leiden observatory, like Oudemans, in his teens. For five years he worked as an observer and suffered with inferior instruments and an uncongenial director until he could stand it no more: He left the university, as Oudemans had done, without taking a doctorate. Kaiser continued observing on his own. After four years he gained attention for calculating the orbit of Halley's comet and as a result garnered a doctorate *honoris causa* from Leiden. Two years later, in 1837, he became *lector* in astronomy and observatory director; an associate professorship of astronomy followed in 1840, and a chair in 1845. For the next two decades Kaiser struggled to obtain funds for renovating his observatory. Before he obtained his desire, he arranged for his assistant Oudemans, one of the first Dutch researchers specially trained in the discipline, to become associate professor of astronomy at the University of Utrecht.[5]

Utrecht, the second scientific center of the Netherlands, had heard sporadic lectures in astronomy since the time of Petrus van Musschenbroek in the eighteenth century, but the serious pursuit of the discipline began with the arrival in 1812 of Gerard Moll as observatory director and professor at the *école secondaire* (to which the university had been demoted by the French-controlled regime). Moll was a polymath physical scientist, in the model of Carl Friedrich Gauss, and he published extensively in Dutch, French, English, and German. Moll had studied at Leiden, becoming *kandidaat* in philosophy in 1809 at a time when the philosophy doctorate still generally went to reward university docents for major accomplishments; his doctorates came *honoris causa* from Utrecht, Edinburgh, and

4 USS. Airy to Oudemans, 4 Jul 1854.

5 *DSB*, "Kaiser," *s. v. De Leidse Sterrewacht: Vier eeuwen wacht bij dag en bij nacht*, ed. Willem Bijleveld (Zwolle, 1983), pp. 32-5; N. D. Haasbroek, *Prof. F. Kaiser en S. H. de Lange in hun relatie tot de astronomische plaatsbepalingen van omstreeks 1850 in het voormalige Ned. Indië* (Delft, 1977), pp. 10-18.

Dublin, and in the 1820s he became a fellow of the Royal Society of Edinburgh and the Brussels Academy.[6]

Although he occasionally published in astronomy, by 1828 Moll had obtained provision for an observer. The first man to hold the position was Gerrit Simons, who had just obtained a doctorate under Moll. After four years he left the field and rose through the ranks of government to become the second director of the royal technological academy at Delft and, finally, minister of the interior.[7] Simons's position then went to Gerardi Regneri Fockens (to reproduce the Latinized Christian names that appear on the title page of publications from the period), another student of Moll's. Fockens seems never to have taken a doctorate. He preferred to publish Latin monographs answering astronomical questions set by one or another learned corporation; some of his texts, such as the one dealing with determining longitude at sea, were major treatises on celestial mechanics and astrometry. He did not take many systematic observations himself, although he could synthesize what others had seen.[8]

After Fockens, in 1839, came Adolf Stephanus Rueb, a thirty-three-year-old *gymnasium* teacher who had completed a doctorate on theoretical mechanics under Moll in 1834. He, like his predecessors, followed Moll in acquiring practical experience with astronomy after having finished his formal schooling and in anticipation of being appointed observer. After four years, he became *lector*, the first teaching post at Utrecht specially intended for astronomy. In spirit, Rueb followed his recently deceased virtuoso mentor; in deed, he was only a smaller copy, publishing irregularly and eclectically. He became an active administrator and popularizer, and he figured in the Dutch movement to abolish slavery in the colonies. He married late and died relatively young, in 1855.[9] Into his place stepped Oudemans.

Professor Oudemans arrived eager to make his mark as a research astronomer. He rejected the universalist tradition of Moll and the amateur exercises of his three predecessor observers. He projected himself as a young man in a hurry. Let us peer over his shoulder as he drafts a letter, in rather stiff French, to British astronomer George Airy about the history of his observatory:

6 Ludovici Gerardi Visscher, *Oratio de Gerardo Moll* [Utrecht, 1838], providing an éloge and extensive bibliography. On Moll's physics: J. P. Kuenen, *Het Aandeel van Nederland in de ontwikkeling der natuurkunde gedurende de laatste 150 jaren* (Rotterdam, 1919) [Rotterdam, Bataafsch Genootschap der Proefondervindelijke Wijsbegeerte, *Nieuwe Verhandelingen, 8*, pt 1], pp. 85-6.

7 H. H. R. Roelofs Heyrmans, "Dr Gerrit Simons," in *Gedenkschrift van de Koninklijke Akademie en van de Polytechnische School 1842-1905*, ed. Roelofs Heyrmans (Delft, [1905]), pp. 41-4; *Nieuw Nederlandsch Biografisch Woordenboek, 5*, eds L. Knappert and P. J. Blok (Leiden, 1921), "Simons," *s. v.*

8 Fockens, *Responsio ad quaestionem astronomicam, 'exponantur atque inter se comparentur diversae methodi, quibus locorum longitudo in mari definiri possit. . .'* (Amsterdam, 1832); Fockens, *De Zonsverduistering van 15 mei 1836* (Utrecht, 1836).

9 "Levensberigt van A. S. Rueb," *Album der Natuur* (1855), *separatum* in the library of the 'Sonnenborgh' Sterrewacht, Utrecht, now located at the Uithof campus.

> After having been attached to the observatory at Leiden for three years, I have been named professor of astronomy at the university in this town and director of the observatory, recently constructed. Astronomy has not had a happy past here. At the beginning of the kingdom, it was combined with physics; Mr Moll was professor of the two sciences at the same time.[10]

Moll, Oudemans implied, did not have a serious commitment to the discipline.

> Later, an observer's post was added to the professorship, for astronomical observations; the latter, however, hardly meant anything. The first [observer], Mr Simons, soon changed careers and now is our minister of the interior. The second was a Mr Fockens, who became, over several years, alienated. His successor was Mr Rueb, who, although like Mr Fockens having many fine qualities, was not an astronomer.

Oudemans, as we shall see, "changed careers" in a fraction of the time that it took Simons to decide to leave Utrecht. He was unfair to Fockens as a theoretician and, to judge from Fockens's surviving notebooks, perhaps even as an observer.[11] The new man slighted Rueb's wider educational activity. Rueb, Oudemans continued, "had a depressed and melancholy character. He died two years ago. In his last year, and under his direction, work was begun on building the new observatory." Here Oudemans credited Rueb with planning the observatory, only in the next paragraphs to describe how the building contained for the most part useless, outmoded equipment: "Apart from a Fraunhofer refractor of 4-inch aperture and a 5-foot focal distance, there is nothing that may produce observations of use for the current state of astronomy." Furthermore, the observatory library lacked even basic astronomical journals. Oudemans asked Airy to help build it up. Then he moved to discuss his own work and reply to previous queries of Airy's. Oudemans conveyed impatience and irreverence at old-fashioned scientific norms. He belonged to the new generation of university researchers.

The nucleus of Oudemans's observatory on the Sonnenborgh hill was a residence given to the university in 1848 by the city mayor, who was also a university curator. The most important facility at the observatory was the new Nederlandsch Meteorologisch Instituut, directed by Christophorus Henricus Diedericus Buys Ballot.[12] A wide-ranging scientist who held lectureships in mineralogy and geology and in theoretical chemistry before becoming associate professor of mathematics in 1847, Buys Ballot

10 USS, "Brievenboek Oudemans." Oudemans to Airy, 5 Oct 1856.

11 USS. Fockens, "Dagboek der sterrekundige waarnemingen gedaan op de Sterrewacht te Utrecht," 2 vols, 1834-37.

12 *Koninklijk Nederlandsch Meteorologisch Instituut 1854-1954* (The Hague, 1954), p. 17.

rose to direct the meteorological institute at its foundation in 1854. When Oudemans first met him, the Utrecht meteorologist still had two years to wait before receiving a chair of mathematics, although his star was plainly rising.[13] For his institute, Buys Ballot obtained astronomical equipment, in particular the good meridian telescope that Oudemans described in his letter to Airy.

As the new man, Oudemans had to strike an arrangement with the ambitious Buys Ballot—technically his equal in rank—to borrow equipment. The astronomer lacked assistants of his own, and his modest salary of *f* 1600 did not permit hiring one.[14] He undertook research and teaching in discouraging circumstances. As Oudemans wrote to Airy, Kaiser had just persuaded the minister of the interior, the former Utrecht observer Simons, to construct a new observatory at Leiden, and this investment would keep astronomy at Utrecht underfunded for a long time to come. The astronomer royal at Greenwich replied in 1856:

> I was almost very sorry to learn from your letter that the construction of another observatory was intended (except indeed it should be useful as an instrument of academical education). For the promotion of astronomy there are already too many observatories. The funds appropriated to a single observatory might—if employed on theory, or on systematic calculation, and on comparison of the past with the present or of theory generally with observation generally—be infinitely more useful than many observatories.[15]

Then, too, Oudemans had become engaged to Paulina Adriana Verdam, ten years his junior and the daughter of a Leiden professor of mathematics. The new salary did not begin to make marriage seem a reasonable prospect. Oudemans did not remain entirely forlorn at Utrecht, for his brother Antoine Corneille then held a postdoctoral assistantship there in chemistry.[16] Yet the young astronomer had prepared himself to bail out at the first opportunity.

His chance came in 1857, when the colonial ministry, at the proposal of Kaiser, sought an engineer to chart the topography of the Indian archipelago by astronomical means. Oudemans became "head engineer of the geographical service in the Dutch Indies," by decree of King Willem III. Under him would be a staff that included several university-trained assistants already in place. In accepting the new post, Oudemans followed the footsteps of his father, who had also opted for a career in the Indies. Having spent a number of years there, Oudemans knew what to expect. He

13 Ewoud van Everdingen, *C. H. D. Buys Ballot 1817-1890* (The Hague, 1953), p. 40.

14 USS, "Correspondentie Oudemans: Ministeries." Contract dated 24 Apr 1856.

15 USS. Airy to Oudemans, 3 Dec 1856.

16 Roelofs Heyrmans, "Dr Antoine Corneille Oudemans, jr," in Roelofs Heyrmans, *Gedenkschrift* [note 7], pp. 117-18.

asked his fiancée to become his wife. The wedding took place in The Hague, and after a short honeymoon in Germany (where the groom spent most of his time visiting with astronomers) Oudemans and his bride set off for the Indies. According to his contract with the colonial ministry, Oudemans started at *f* 7200 per year. The salary would increase by *f* 600 annually until he attained the astonishing income of *f* 14,400.[17] The salary, enormous by Dutch standards, would erode quickly in the tropics. As Oudemans explained in a letter to Kaiser, "one needs at least 500 guilders per month here to live decently when married and without children," and this sum did not take account of capital expenses necessary for setting up a household.[18] Furthermore, Oudemans had to spend some *f* 1000 for his transport to Batavia.[19] For all this, it remained that in about twelve years Oudemans could anticipate earning a salary an order of magnitude greater than if he had remained at Utrecht.

## Science and Empire: Practical Knowledge and Pure Learning

Behind Oudemans's survey of the Indies lay a dual mandate. First, he had to produce detailed maps by the standard procedure of topographical triangulation—following a straight line cross-country for several hundred kilometers and establishing large towns at the apexes of triangles. Second, to verify his positions independently, he had to determine the coordinates of each triangular apex by astronomical means. The two calculations would be expected to deviate from each other due to the perturbing effect of mountain masses on the figure of the earth. The Amsterdam Academy of Sciences expressed interest in the general survey, and it supported the astronomical side as an exercise in pure learning.

From the moment of Oudemans's arrival, problems arose over the dual nature of his responsibilities. The military and agricultural authorities wanted good maps of the Indies, Oudemans wrote to Kaiser in 1858. The navy, however, remained cool toward the need for detailed longitude and latitude measurements—the second part of Oudemans's mandate. The astronomer could not say whether he would be able to arrange for his astronomical measurements. If he were unable to obtain "support for carrying out my goals of taking position readings in the archipelago," then he would resign himself to his "fate" and just continue with the triangulation.[20] The problem lay with the top-heavy bureaucracy: Superimposed on the Arcadia of the Indies came a Byzantium of Dutch administrators. "One really has to be here," Oudemans wrote to Kaiser in 1858, "to obtain an

17 USS, "Oudemans: Sterrewacht." Oudemans to Naval Ministry, 13 Jul 1857.

18 USS, "Brievenboek Oudemans." Oudemans to Kaiser, 11 Jan 1858.

19 *Ibid.* Oudemans to Kaiser, 10 Feb 1858. Haasbroek, *Prof. F. Kaiser en S. H. de Lange* [note 5], p. 244, cites a letter from the colonial minister to Kaiser, 9 Apr 1857, where the terms of Oudemans's appointment include free first-class transport; the salary schedule is what Oudemans seems to have in fact received.

20 USS, "Brievenboek Oudemans." Oudemans to Kaiser, 11 Jan 1858.

idea of the complicated administration and the rules, of the complicated detours that documents have to follow before a decision can be taken, and the enormous loss of time accompanying every step" of one's progress.[21]

Oudemans's excuses did not impress his former patron, who quickly arrived at the judgment that Oudemans had a hopeless task. The young astronomer was unconcerned. He wrote to his successor at Utrecht, Martinus Hoek: "I can readily understand that Kaiser declared my mission to have been a failure after [reading] my first letter. I trust, however, that subsequent letters will have given him reason to change his mind."[22] Oudemans hoped that Kaiser would come to appreciate the material difficulties surrounding astronomy in the colonies:

> Except for Java, no big roads or horses are to be found, the coasts in various places are unapproachable and the inlands do not offer anything but marshes... [and] the first half year eastern winds and the other half year western winds prevail.... They [engineers] have to drag themselves with chronometers and instruments from one place to the other. For each expedition we depend on the solution to the big question: How shall I get to the places to be defined [geographically]?[23]

In most cases, Oudemans depended for his travels on the availability of naval steamers.

Kaiser's negative opinion of Oudemans's task derived from his experience with an earlier Dutch attempt to survey the Indies. In the late 1840s Kaiser had extended support to the proposal of a naval lieutenant at the Royal Naval Institute in Medemblik, Sjoerd Hendrik de Lange, to make astronomical observations in the Indies in order to improve sea charts. Since taking a *kandidaats* examination with Kaiser in 1845, De Lange had tried unsuccessfully to set up an observatory at Medemblik, and the Indian proposal effectively asked for one in the colonies. Kaiser, in 1848, informed the minister of colonies and the navy that it would not be well to endow De Lange's scheme with equipment that was lacking at Leiden. He thought that De Lange, although not as talented an astronomer as Oudemans, would be able to carry out the work on Java after six months' additional training at Leiden. The minister followed Kaiser's recommendation, and in 1850 De Lange received an appointment as geographical engineer under the governor general, at a salary *f*5400 per year. He set off with *f*3373 worth of equipment, including three telescopes, four chronometers valued at nearly *f*1200, and a 160-page book published by Kaiser about using astronomical observations to determine geographical position. Kaiser understood De Lange's charge to include pure science, and in 1853 he severely criticized the naval lieutenant for not devoting time to astronomi-

21 *Ibid.* Oudemans to Kaiser, 10 Feb 1858.

22 *Ibid.* Oudemans to Hoek, 11 May 1858.

23 *Ibid.*

cal observation and discovery. De Lange died in 1855, having accumulated a number of observations. He was succeeded by his brother Geldolph Adriaan de Lange, who had assisted him but who was no astronomer. Kaiser negotiated with the colonial minister (colonies had hived off from the navy by 1850) to appoint a former student as De Lange's assistant, but he really wanted to send a first rate astronomer to the Indies. As early as 1855 he thought of Oudemans in this regard, and Martinus Hoek's name also came up, but at this time the mooted position was only an assistantship. When Oudemans informed Kaiser about the difficulties faced by the project, Kaiser threw up his hands in despair.[24]

With Oudemans having been catapulted to direct the triangulation work, G. A. de Lange resigned. The ex-professor from Utrecht wanted to call one of his talented Dutch colleagues to fill the slot at *f* 4800. Oudemans thought of three men: Hoek, who had succeeded him on the Sonnenborgh; Lewis Cohen Stuart, a docent of geodesy at Delft who had obtained an engineering diploma there in 1848 under Gerrit Simons (and who went on to direct the school himself); and Hendrik Willem Schroeder van der Kolk, a young physicist at Utrecht.[25] If none of the three would come, then he preferred a certain Zirks, or an "efficient German" such as Eduard Schönfeld (soon to rise to direct the Baden observatory at Mannheim) or Wilhelm Förster (the future director of the university observatory at Berlin).[26] Oudemans wrote to Hoek, urging him to come to Batavia as second-in-command of the geographical service. The two astronomers would then work on determining longitudes across the entire archipelago, leaving the detailed triangulation to the barely competent subordinates.[27] Oudemans envisaged training Indian army officers for the surveying tasks, provided that a colonial general staff came to be organized. Obtaining funding for assistants involved delicate negotiations, he wrote to Kaiser, because he remained partially under the jurisdiction of the navy.[28] Hoek, Cohen Stuart, and Schroeder van der Kolk, however, declined Oudemans's invitation, and the possibilities reduced to reappointing De Lange—this despite Kaiser's low opinion of the former engineer.[29]

By 1859 Oudemans had resolved to concentrate on calculating Bata-

24 Haasbroek, *Prof. F. Kaiser en S. H. de Lange* [note 5], pp. 27, 31, 43-5, 47, 50-1, 61 on S. H. de Lange's preparation and appointment; pp. 144-7 on Kaiser's criticism of S. H. de Lange; pp. 224-51 on Kaiser's efforts to find a trained replacement for S. H. de Lange. Haasbroek's monograph is unusually convoluted and repetitive, but it contains a wealth of information.

25 USS, "Brievenboek Oudemans." Oudemans to Kaiser, 10 Feb 1858; Oudemans to Schroeder van der Kolk, Apr 1858. On Cohen Stuart: "Simons, Dr Gerrit," in *Encyc.*, *s. v.*, and Roelofs Heyrmans, "Dr Lewis Cohen Stuart," in *Gedenkschrift* [note 7], pp. 111-12. H. W. Schroeder van der Kolk, *Specimen physicum de methodis quibus resistentia galvanica determinatur, metallorum imprimus, quod*... (diss., Univ. Utrecht, 1860). On Schroeder van der Kolk's physics: Kuenen, *Aandeel van Nederland* [note 6], p. 87.

26 USS, "Brievenboek Oudemans." Oudemans to Kaiser, 10 Feb 1858.

27 USS, "Brievenboek Oudemans." Oudemans to Hoek, 11 Apr 1858.

28 *Ibid.* Oudemans to Kaiser, 23 May 1858.

29 *Ibid.* Oudemans to Hoek, 24 Aug 1858; Oudemans to Johannes Bosscha [1858].

1. J. A. C. Oudemans (with cane) performing topographical duties on Java. Courtesy of Dr T. de Groot, Rijksuniversiteit Utrecht.

via's longitude from the observations of De Lange. His broader plans, he confided in a letter to Kaiser, depended on uncertain local funding and travelling on naval steamers. At least in the early years when the Indian regime enjoyed considerable independence, Oudemans had to resort to intense politicking to negotiate between the governor general's office, which would authorize supplementary funds, and the colonial ministry, his employer:

> Concerning the further duties of the Geographical Service, if a steamboat is not available, and I have not dared yet to advance a proposal about that, then I won't be able to project work for more than two or three years, namely defining longitude with the telegraph of some other places on Java, and defining longitude by means of the chronometers of the main locations in the Outer Possessions.

One could not travel by sail because of the time involved in tacking against the wind. A commercial steamboat would then be necessary. Longitude at points in the interior could not be determined by gunpowder signals or rockets, as travel was too hazardous.[30] Here we see Oudemans's early plan to survey the entire archipelago, with special attention devoted to the

30 *Ibid.* Oudemans to Kaiser, 25 Mar 1859.

Outer Possessions. Throughout his stay in the Indies, Oudemans continually sought to include the Outer Possessions in his geographical mandate, and he received more than casual government support for his plans. Mapping the Outer Possessions was, indeed, a task preliminary to their systematic exploitation. Most writers have until recently portrayed serious government interest in the Outer Possessions as a late nineteenth-century development.[31] Yet in leaving the Netherlands, Oudemans the astronomer had exchanged his academical *biretta* for a colonial pith helmet: He prepared the cutting edge of new imperialist incursions. His travels, indeed, depended on when naval gunboats could be spared from policing actions. As he wrote to Kaiser in 1859:

> The Naval Dept received the approval of the government to make a steamboat available for an expedition with regards to the defining of the already mentioned points [in the Outer Possessions], as soon as this would be feasible. Nothing has happened yet. Maybe after the expedition to Boni is finished, but then they will probably have to send troops to Palembang.[32]

Within three years he could report to his colleague Christian August Friedrich Peters at Altona, that he was writing up reports

> 1) about the trip of De Lange in 1852 to define the longitude of Menado, lunar observations, and anemometer measurements; 2) trip of [Carl Friedrich Julius] Jaeger of this year to Muntok, Palembang, and Singapore; 3) my trip of this year to Muntok, Riau, Palembang, Djambi, Singapore, etc.; 4) observations of the eclipse of the sun on 8 July and of the passing of Venus across the sun on 12 November 1861.[33]

Oudemans the astronomer travelled widely in the service of his imperialist employer.

As the preceding extract suggests, Oudemans never ceased to see himself as a professional astronomer who, for a time, had come to be employed as a topographical engineer. In 1858, soon after he had arrived at Batavia, he wrote to Johann Heinrich Mädler, director of the German observatory at Dorpat, sending along corrections and additions to Mädler's star catalogue. The young man in the colonies was bursting with self-importance:

> I take the liberty of urging you to publish these details in the name of science. Maybe you will find this arrogant of me, but

31 M. C. Ricklefs provides a corrective in *A History of Modern Indonesia* (London, 1981), pp. 114-42. Compare: Robert Van Niel, "The Course of Indonesian History," in *Indonesia*, ed. Ruth T. McVey (New Haven, Conn., 1967), pp. 273-308, on p. 289.

32 USS, "Brievenboek Oudemans." Oudemans to Kaiser, 25 Mar 1859.

33 *Ibid.* Oudemans to Peters, 31 Dec 1862.

> when you consider that others have also expressed the desire to see the star positions included, then you will probably decide to act on the matter.

Oudemans wanted to be in contact with the lights of European astronomy. He urged Mädler to remember younger colleagues, himself in particular, when Mädler sent out reprints. "I hardly have to mention how isolated one's position is here in the East Indies, especially with regard to scientific material."[34] The same year Oudemans elaborated his feelings in a letter to Karl Ferdinand Pape, an observer at Altona. "There is so much at stake for me to receive the *Astronomische Nachrichten* number after number, and not when a volume has been completed." These are the words of a scientist eager to remain on the frontier of research, not those of an engineer retaining only a casual interest in science.

Oudemans continued to Pape: "You don't have any idea about how isolated a scientist in a colony is. . . . I desperately need the continuous flow of scientific journals to stay on top and to bring about order in this climate." Life was expensive at Batavia, he went on, but he had resolved to spend money on acquiring the tools needed for scientific research. "There are some bookstores here, three or four, but they turn the *métier* into a public swindle. If one wants to keep informed and remain at a certain level, then one has to pay for many things." The KNV and the Bataviaasch Genootschap had libraries, but "uncongenial surroundings" discouraged their use for scientific research.[35] By Oudemans's time, the Genootschap—the senior scientific society—had become a club for Indological discussion. Yet it received substantial funding from the colonial regime, and as a resident savant, Oudemans became a member upon his arrival. He soon resigned because he "did not agree with their financial administration." The officers of the Genootschap received *f* 100 each, and *f* 300 was available for stationery. Yet it carried a debt of *f* 18,000, which it wanted the government to cancel, and at the same time it asked for an increase in its subsidy from *f* 4000 to *f* 8000.[36] Struggling to obtain money for astronomy, at the beginning Oudemans declined to be associated with the lavish proposals of rival men of learning.

After four years at Batavia, Oudemans still sought encouragement from European astronomers. When Schönfeld rose to a professorship at the Baden observatory, Oudemans quickly seized the occasion to call attention to himself:

> My honourable Schönfeld! With the title and with the permanent position! I had seen that you received the chair several

34 *Ibid.* Oudemans to Mädler, 30 May 1858.

35 *Ibid.* Oudemans to Pape, 9 Dec 1858.

36 USS, "Oudemans: Officieële Stukken van my particulier gericht." Oudemans describes his first encounter with the Bataviaasch Genootschap and provides the financial arrangements in a note written on his diploma of renewed membership, dated 4 Jun 1872.

> months ago, but the location of the appointment remained unknown to me. I am hurrying to drop you a line and show you that I am alive and to assure you of my lasting friendship and respect, which I would have done earlier if I had known where you had gone. My reason for writing is, of course, not completely unselfish. I want to revive the memories of the time approximately four years ago, of an interrupted correspondence with you and all the rest of the German friends. That I am longing for this correspondence even more now than in Holland is understandable.[37]

As geographical demands claimed increasing amounts of time, Oudemans's commitment to astronomy remained strong. In his twelfth year at Batavia, in 1869, he sent a paper to the *Astronomische Nachrichten* on stellar occultations. He could manage no more: "In several days I must travel again to the western coast of Sumatra," he wrote to Peters, the editor.

> I shall have a new war steamer at my disposal. Except for the islands east of Java, I have been almost everywhere in our archipelago. So I shall devote myself more than likely mainly to [positional] measurements.

His scientific career had to wait for a time. Only after his geographical duties had been satisfied could he "devote [himself] for several years to astronomical goals."[38]

Despite his apologetics, Oudemans never lost an occasion to publish a scientific result in Europe. In 1864 he corresponded with Peters on variable stars. His observations revealed an earlier minimum than one reported by Schönfeld. In 1868 and again in 1871 he coordinated extensive eclipse observations throughout the Malay archipelago, giving instructions to naval officers as well as to tea planters.[39] In 1871 he asked Norman Lockyer, editor of the British periodical *Nature*, to print a comment on photographs of a recent solar eclipse taken by a British team in Asia. Oudemans indicated that his results were much better, and he included photographic prints to support his case. He emphasized that he had sent copies of the prints to seven other British astronomers, as well.[40] In 1873 he addressed Hervé Faye, president of the Academy of Sciences in Paris, on corrections to a recent article of Edmond Dubois's where Dubois discussed the influence of atmospheric refraction on determining the moment of

37 USS, "Brievenboek Oudemans." Oudemans to Schönfeld, 20 Jul 1861. The draft is crossed out, presumably indicating that it was not sent.

38 *Ibid.* Oudemans to Peters, 30 Apr 1869.

39 Oudemans, "Verslag over de waarneming der totale zoneclips van 18 augustus 1868," *NT*, *33* (1868), 51-90; Oudemans, *Bericht aangaande de waarnemingen, gedaan bij gelegenheid der totale zonsverduistering van 12 december 1871...* [Batavia, 1872]. The planters were R. A. and R. E. Kerkhoven of the Ardjasari tea plantations.

40 USS, "Brievenboek Oudemans." Oudemans to Lockyer, Sep 1873.

contact in the passage of Venus across the sun's limb.[41] At the same time, during his fourteenth year at Batavia, he sent Peters four notes for the *Astronomische Nachrichten*: the longitude difference between Singapore and Batavia; a result of Kaiser's for the Foucault pendulum; a correction in a geophysical calculation; and observations of the 1871 solar eclipse.[42] The "geographical engineer" Oudemans was one of the most accomplished Southern-Hemisphere astronomers of the nineteenth century.

## The International Dimensions of Colonial Research

Oudemans became especially adept at initiating international projects that would serve to advance his career in astronomy. His principal collaborators were British. From the time of Raffles, British and Dutch interests in Southeast Asia complemented each other, surviving apparent *contretemps* such as Rajah James Brooke's incursion into Brunei and Sarawak and attempts by the Acehese to obtain support from London. The Anglo-Dutch treaty of November 1871, which concerned Aceh in northern Sumatra, the Gold Coast in Africa, Surinam, and British India, is one of the most amicable and far-reaching of the nineteenth-century imperialist 'understandings.'[43] Fortunately for Oudemans, the British allies were also a major power in colonial astronomy. British coaling stations from Gibraltar to Singapore had astronomical facilities. British astronomers compiled the best star charts of the southern skies from the observatories at Madras and Cape Town. In the 1850s at Utrecht, Oudemans corresponded with British astronomers in French. During his colonial experience, he completely mastered the English language.[44]

The laying of submarine telegraphic cables brought great precision to measurements of longitude. By the late 1860s, with the end of the triangulation of Java in sight, Oudemans was in a position to make good use of a telegraph line from Singapore to Madras. As a result he came into contact with Norman Pogson, director of the Madras observatory. Throughout his Indian years, Oudemans often worked with flawed specimens of humanity such as might have stepped out from the pages of a novel by Joseph Conrad. He was pestered by his brother, a sometime colonial geographical engineer. He suffered incompetent European assistants. About a certain Dutch calculator he wrote to Kaiser: "The man is so stupid, so ignorant, that he is of no value to me, on the contrary he is a nuisance. I cannot bring myself to forgive you for hiring him."[45] Pogson, afflicted (as he wrote) with

41 *Ibid.* Oudemans to Faye, Sep 1873.

42 *Ibid.* Oudemans to Peters, 25 Oct 1873.

43 Ricklefs, *Modern Indonesia* [note 31], p. 136.

44 While at Utrecht in the 1850s, Oudemans wrote to Airy in French and to the American astronomer Benjamin Apthorp Gould in German; as late as 1858 he was writing to British astronomers at the Cape of Good Hope in French. USS, "Brievenboek Oudemans."

45 *Ibid.* Oudemans to Kaiser, 25 Mar 1859.

"the deepest mental depression," was one of this odd collection.[46]

In 1871 Oudemans arranged with Pogson to exchange signals over a Madras-Singapore telegraph line. It was a difficult plan to execute. Oudemans had to travel to Singapore; the cable company had to contribute an open line. The two astronomers exchanged signals. Oudemans analyzed his data and then asked for Pogson's reductions, so that the longitude difference could be calculated. The simple request, made in a collegial spirit, brought no result. After four years of silence, Pogson responded, to the effect that he wanted Oudemans's data so that he could publish the results first: "After the extraordinary delay which has occurred I claim the *privilege of first reduction* and the favour of your records for the purpose of making it."[47] Pogson wrote to Oudemans only because his lethargy had been the subject of a diplomatic note from the governor general's office in Buitenzorg to the governor's office in Madras. Oudemans, who had ready access to outlets for publishing the result, would have liked to break the news first, but by 1875 he wanted it to appear regardless of who would claim priority. He had his governor general transmit the Batavia data to the Madras governor, along with the request that Pogson remit his material.[48]

Oudemans's concern over finishing the longitude calculation related to his broader academical ambitions. He kept hoping to receive a chair of astronomy in the Netherlands. In 1872 he watched while Hendricus Gerardus van de Sande Bakhuyzen succeeded Kaiser at Leiden. He had reason to believe that his own chance was coming. In 1873 he received word from his friend Johannes Bosscha, who had just been appointed professor of physics at the Delft Institute of Technology. Bosscha, who five years later would rise to direct the institution, relayed the circumstances of Hoek's death and asked how Oudemans would feel about returning to Utrecht: "Some people feel that his place should be kept open until you get back from the Indies, a course that does not seem objectionable." Bosscha suggested that Oudemans had best complete what was before him. "And your work in the Indies is important enough to make it your life's task. When you arrive back here after a mission well done, then I believe that you will have no trouble finding a good position here." Bosscha relayed clear signals that Oudemans had to wind up his affairs at Batavia if he did not want to miss an Utrecht professorship.[49] And so, in 1875, Oudemans went through diplomatic channels to obtain Pogson's data. He explained in a letter to Pogson that he had asked the governments of the Indies and Madras to intervene because he would not be at Batavia much longer. He would return to Utrecht as Hoek's successor:

46 USS. Pogson to Oudemans, 18 Jul 1871.

47 USS, "Singapore-Madras." Pogson to Oudemans, 22 Jun 1875.

48 *Ibid.* Governor General of the Dutch East Indies to Governor General of Madras, [1875], copy.

49 USS. Bosscha to Oudemans, 21 Sep 1873.

> It is the same place I occupied in 1856-57, but now the post is a chair, whereas formerly it was an associate professorship, and I have earned my pension for Indian service next month, so that as Indian pension and Home appointment may be combined, the pecuniary circumstances are less onerous than before.[50]

The matter dragged on until 1882, when, from his Utrecht post, Oudemans finally pried the data out of Pogson. The man in Madras had been sitting on his figures, hoping that funds would come through enabling him to publish first.[51]

While he waited in Batavia Oudemans knew that his ultimate return to an academical bower would be sped by favorable foreign opinion. We can imagine his chagrin, then, when his correspondent from earlier times, Astronomer Royal George Airy, wrote to him in January 1873 with information about the visibility of the 1874 transit of the planet Venus from Batavia. "I hope that you still retain your love for astronomy," Airy concluded, "and that you may be induced to watch for this phenomenon."[52] Oudemans quickly conveyed his professional interest in the matter. There would indeed be an attempt to observe the transit from Batavia, but he hoped to travel to northern Japan for the event. Oudemans left no doubt that he still belonged to the astronomical fraternity. He wrote, in creditable English:

> I hope as you receive the German translation of my eclipse-rapport [the event of 12 December 1871] in the *Astronomische Nachrichten* will at last be taken up, and I hope you will see by it that I really still retain love for astronomy although my official business regards more the application of it and further geodesy.[53]

Oudemans would have been especially testy about his isolation from European astronomy because he was just passed over in the selection of a successor to the chair of his patron at Leiden, Frederik Kaiser. We can infer his mixed emotions in receiving, a number of weeks after responding to Airy, a letter from Van de Sande Bakhuyzen, whom the Amsterdam academy had designated to coordinate observations of the transit of Venus:

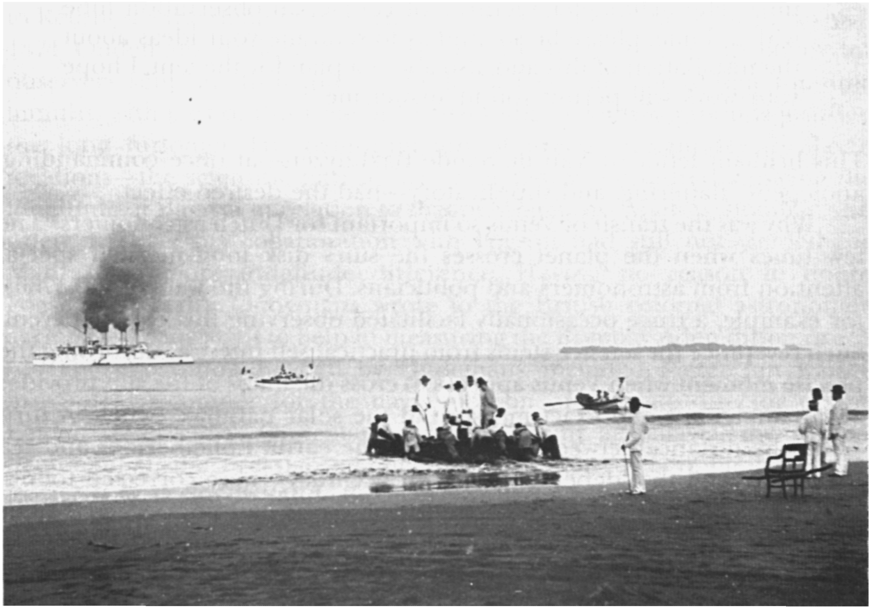
> It is with great pleasure that I pick up the pen to write you from the Observatory. On the one hand, I feel reluctant to do so because there is the thought that you, in many ways, would be

50 USS. Oudemans to Pogson, 28 Jul 1875, draft.

51 USS, "Lengteverschil Singapore-Madras." Pogson to Oudemans, 25 Jun 1882.

52 USS, "Venus Expeditie," Airy to Oudemans, 7 Jan 1873.

53 *Ibid.* Oudemans to Airy, 8 Mar 1873, draft.



2. Unloading astronomical equipment from a Dutch warship for an eclipse expedition in the East Indies during the middle of the nineteenth century. The palanquin is for Oudemans. Courtesy of Dr T. de Groot, Rijksuniversiteit Utrecht.

> better prepared to fulfill the task given to me of succeeding our mourned Kaiser; on the other hand, I look forward to finding a reason to get to know you better through my new job. Your astronomical writings, and especially the way in which Kaiser always spoke about you and presented you as an example, have made a great impression on me. I want to start or have a chance to correspond with you and, later, I hope to meet you in person.

Van de Sande Bakhuyzen sought to defuse a potentially difficult situation, for he needed Oudemans's good will:

> With some astonishment I read about my appointment in the newspaper in Leiden. . .; especially after a conversation with Kaiser of approximately a year ago, I had imagined another course of action. I do not want to discuss the circumstances that may have given rise to the decision, but I can assure you that, now that I have been appointed, I will continue the work of Kaiser in his spirit and with all my power. I shall prepare the plans for the Venus expedition, but we still have a full year before the instruments need be sent, and this gives us much

> time. The heliometer requires, of course, an observation tube with a dome; please be so kind as to send me your ideas about the installation of this and also about a plan for the tent. I hope your work will permit you to answer me.[54]

This brilliant letter by Van de Sande Bakhuyzen—at once commanding, apologetic, flattering, and supplicatory—had the desired effect.

Why was the transit of Venus so important for Dutch astronomers? The few times when the planet crosses the sun's disk long merited special attention from astronomers and politicians. During the wars of the 1760s, for example, a truce occasionally facilitated observing this celestial event. Such reverence for science stems from practical self-interest. Recording the precise moment when Venus appears to cross the limbs of the sun provides an unambiguous and exact measure of the solar parallax, which in turn yields the distance between the sun and the earth. Ephemerides and sea charts—and all that depended on their accuracy—were corrected following observations of the event. A transit of Venus had not occurred since 1769. The 1874 event attracted around half as much international attention as its eighteenth-century predecessor had, but astronomers remained mindful that the more observations of the transit taken, the greater the accuracy of the value for the solar parallax.[55]

Oudemans keenly anticipated travelling to Japan for the transit, he wrote to the Amsterdam academy, but he wanted official government support for the expedition north:

> Chronometers and universal instruments I can take along from the geographical service. . . . I would like the trip to be made on an order from the government. So far I have not heard anything to that effect. In that case, I would be reimbursed for the trip and for the costs I incur. My desire is, then, that the colonial ministry address the governor general of the Dutch Indies to ask me to observe the transit of Venus in Japan, etc., etc.[56]

Oudemans knew that if the expedition were official government business, then he might hope to be assigned a Dutch warship—with its complement of officers trained in astronomical navigation. But because the colonial regime was at that time fighting a major war in northern Sumatra with the Kingdom of Aceh, Oudemans could not count on a naval vessel for his purposes.[57]

The Dutch effort divided into two expeditions, one to Japan and one

54 *Ibid.* Van de Sande Bakhuyzen to Oudemans, 8 Mar 1873.

55 Woolf, *The Transits of Venus* [note 1], pp. 140, 187, lists 120 sites for observing the 1761 transit and 150 sites for observing the 1769 transit. George Forbes, *The Transits of Venus* (London, 1874), pp. 92-3, estimates 75 sites for observing the 1874 transit, at a total cost of £ 150,000 to £ 200,000.

56 USS, "Venus Expeditie." Oudemans to Amsterdam Academy, 11 May 1873, draft.

57 *Ibid.*

to Réunion—the small French island possession near Madagascar. Early in 1874 Oudemans decided to travel west to Réunion, leaving Japan for observers sent out from the motherland. He would be absent for nine months, with part of this time in British India. Scientific grounds justified the long furlough. His determination of precise longitudes for Javan locations—the scientific part of his triangulation—required knowing the longitude of Batavia in relation to that of Singapore, Madras, Bombay, and Aden. In 1874 his collaboration with Pogson had still not yielded the Madras-Singapore longitude difference. Having no reason to doubt Pogson's sincerity, Oudemans wrote to the British colonial astronomer, asking for an assistant to help in measuring the Bombay-Aden difference.[58]

The expedition headed by Oudemans included Pieter Jan Kaiser, instrument examiner for the navy and son of the late director of the Leiden observatory; Oudemans's chief assistant at Batavia, the former lieutenant in the Prussian engineering corps Carl Albert Emil Metzger; Ernst Frederik van de Sande Bakhuyzen, observer at Leiden and eventually successor of his brother H. G. as director there; and two young Dutch astronomers, Martinus Bernardus Rost van Tonningen and T. F. Blanken. Oudemans and Metzger travelled from Batavia to Réunion via Singapore and Aden. The observers from the Netherlands took a mail steamer out of Marseilles. The enterprise received *f* 26,000 from the educational section of the interior ministry; various Dutch societies also contributed, principal among which being the Teyler's Stichting's grant of *f* 4400 for instruments.[59]

Few more precipitous declines in scientific prestige are known than that which occurred in France between the 1830s and the 1870s, a decline documented in the languages of Oudemans's correspondence. It comes as little surprise, then, that even though Réunion belonged to the French overseas empire, Oudemans had most traffic with the British. His principal collaborator was David Gill, who observed the transit from the island of Mauritius, near Réunion. Gill, the former Aberdeen watchmaker and future astronomer royal of Cape Town, was at the time employed by the twenty-sixth Earl of Crawford, James Ludwig Lindsay, to design and construct a sumptuous private observatory at Dun Echt near Edinburgh.[60] A part of the extensive correspondence between Gill and Oudemans concerned arrangements among the British, German, and Dutch expeditions for determining longitude differences over various segments of telegraph line between Perth and Berlin. Such determinations required coordination

58 USS, "Venus Expeditie." Oudemans to Pogson, May 1874, draft.

59 Preparations for the Dutch expedition are detailed in printed circulars: V. S. M. van der Willigen, F. J. Stamkart, and H. G. van de Sande Bakhuyzen, "Rapport aan de Koninklijke Akademie van Wetenschappen," 29 Nov 1873; C. J. Matthes, "Instructie voor de Venus-Expeditie," 30 May 1874. Copies are located in USS, "Venus Expeditie." Van der Willigen published several long descriptive accounts of the expedition in the Haarlem *Courant*, among which: "De Nederlandsche Expeditie ter waarneming van den overgang van *Venus* voorbij de zon," 15 Aug 1874.

60 "Gill," *DSB*, *s. v.*

of travel plans by each expedition.[61] Gill and Oudemans also pondered how to exchange signals between their two neighboring islands, which lacked a telegraph connection.[62]

As leader of the Dutch expedition to Réunion, Oudemans had to carry out the detailed instructions of the Amsterdam academy. The scientific section of the academy precisely specified the tasks of each member of the expedition. Although their solicitations reassured public and private patrons and also cautioned overenthusiastic observers, the instructions aimed to preserve the transit data from any possible calamity, natural or civil. Each of the senior observers—Oudemans and Kaiser—had to keep a rough notebook of observations and comments. Two copies of all final, raw figures were to be made and returned separately to the Netherlands. The Batavian astronomer, however, chafed under the inflexible conditions set by his superiors, and seven weeks before the transit took place he wrote to alert Amsterdam of a major change in procedures. Oudemans, as the leader of the expedition, would continue to send progress reports to Amsterdam. He would keep an astronomical notebook, while Kaiser recorded progress on the photographical front. There would be separate notebooks for the raw observations. Oudemans and Kaiser would bring their notebooks home, and copies of the data would find their way separately to the academy.[63]

When the academy learned about Oudemans's proposals a mere five weeks before the celestial event, it remained firm in its original evaluation of the situation. The observations would take years to reduce, but only as a result of such diligent work could there be a publication "that will be an honor for the academy and a monument for posterity." The academicians reminded Oudemans that the government had invested *f* 40,000 in the expedition, and private sources had contributed *f* 15,000. The investors "will expect that as many precautions as possible have been taken to make the expedition a success." The instructions guaranteed the desired outcome. The academy doubted the wisdom of dividing up the data notebooks and eliminating the duplicate copies. It absolutely insisted that the preliminary reductions remain at Réunion until the raw data arrived in Amsterdam. It urged the observers to "spend the time still left at Réunion by preparing well synthesized reports from their observations and also have one set of books at Réunion and one be sent to Europe." To alleviate some of the extra work that this course entailed, the academy allowed Oudemans and Kaiser to keep their daybooks for later analysis.[64] Oudemans and his observer colleagues flatly refused to go along with the

61 USS, "Venus Expeditie." Gill to Oudemans, 16 Sep 1874

62 *Ibid.*, and Oudemans to Gill, 27 Sep 1874, draft.

63 *Ibid.* Oudemans to Amsterdam Academy, 15 Oct 1874.

64 *Ibid.* Amsterdam Academy (Venus Commission) to Oudemans, 19 Nov 1874.

academy's wishes, following, instead, their own plans for reducing the data.[65]

## Imperial Science in the Service of Metropolitan Ambitions

When Oudemans returned to Utrecht, he was at first uncertain about his future goals. "What I will do to occupy myself I have not yet decided," he wrote to a German colleague. "For the moment I don't regret that the professorship does not allow me to take any serious observations. If you have an idea about this, please let me know."[66] The future was not clear in 1875. The pensioned Indian civil servant could not anticipate that he would never again undertake any scientific work more significant than that relating to the topography of the Indies.

Financial considerations determined Oudemans's destiny. He had been drawn to Batavia by the high salary and the prospects of an annuity after twenty or so years. Beginning in 1875 he drew *f*3600 per year as a pension. It was not a princely sum, being only one half the amount enjoyed by the former president of the high court of justice of the Indies.[67] Oudemans's salary as professor and observatory director came to around *f*4000.[68] Together with his pension, the university income would have provided well for Oudemans's numerous family. (He had remarried in 1868 after the death of his first wife, and he had children from both unions to support.)[69] The Dutch government, however, took a dim view of this *cumulation*, and when a retired civil servant obtained another government position, either his pension or his salary was garnished. In 1873, with the liberalization of laws in favor of colonial civil servants, an Indian pension would still be reduced by one-third if a pensioner concurrently received a state salary above a certain threshhold.[70] Taken together with deductions for survivors' benefits, the law reduced Oudemans's disposable income from around *f*7600 to *f*5600.[71] As the law fixed professorial salaries, Oudemans could only add to his income by taking on additional chores.

Oudemans found the circumstances surrounding his new position a bit disheartening. The Utrecht observatory, he wrote to Otto Struve at Pulkovo, had been "neglected," and he wanted to "create order" in what his

65 *Ibid.* Oudemans to Amsterdam Academy, 17 Jan 1875.

66 USS, "Brievenboek Oudemans." Oudemans to unknown (in German), [1876].

67 USS, "Correspondentie Oudemans: Ministeries." A. J. Swart to Colonial Ministry, n.d.; Oudemans to A. J. Swart, 17 May 1886; Oudemans to King Willem III, 14 Feb 1889.

68 USS. Interior Ministry, Section O, 15 Feb 1881, N° 526, where Oudemans's salary is raised from *f*4000 to *f*5000.

69 H. G. van de Sande Bakhuyzen, "Oudemans, Jean Abraham Chrétien," in *Nieuw Nederlandsch Biografisch Woordenboek*, eds P. J. Blok, *et al.* (Leiden, 1911-37), *s. v.* "Oudemans," *NP*, *35* (1949), 195-6.

70 USS, "Correspondentie Oudemans: Ministeries." Oudemans to Swart, 17 May 1886; Interior Ministry, Cabinet, 21 Apr 1875, N° 76. where Oudemans receives a pension of *f*2200.

71 USS, "Sterrewacht Correspondentie." Oudemans to University Curators, Aug 1887.

predecessor Hoek had left him.[72] Hoek had, in fact, not done much observational work, although his research on optics and the ether drag—undertaken in collaboration with Oudemans's brother Antoine Corneille Oudemans—guaranteed him a secure place in the annals of science.[73] Oudemans lived some distance from his office, a circumstance that impeded research. He emphasized in a letter of 1880 to the university curators:

> As soon as an astronomer has chosen some field or part of astronomy—to master the whole field would be impossible for anyone—then he will be obliged to spend time with his instruments at irregular intervals, not only at night but also during the daytime. It is possible that he has to observe early in the evening, which will take up to 15 minutes of his time, and that he has to observe again only several hours later, because the object to be observed can then be seen or the celestial body is not high enough in the sky. Often there also have to be verifications of the instruments, for which the presence of the astronomer is not necessary the whole day; almost always an astronomer has to make preparations before an astronomical observation, for which the necessary items are located in his study, and these cannot be transported to the observatory all at once. These arguments mean that travelling to the observatory should detract from the performance of the astronomer. . . . It is a truth among astronomers, that only at observatories taking regular and constant observations are students educated. Even the first-year students will work with more *con amore* if they know that, when they go to the building, the professor there can help them with their difficulties.[74]

Oudemans also had to share his observatory buildings with his old rival Buys Ballot.[75] The cooperative arrangement became intolerable in 1882, when Oudemans urged the government to transfer Buys Ballot's operation to a seaport (or at least to another location in Utrecht) and refit the principal meteorological building as the observatory director's house.[76]

The solution to Oudemans's financial uncertainties came in the form of a request on the part of the colonial ministry to have the Utrecht astronomer continue mapping the Malay archipelago. The government needed his expertise and dedication. Previously, in 1871, it had directed

72 USS, "Brievenboek Oudemans." Oudemans to Struve, 14 Sep 1877.

73 "Hoek," *DSB*, *s. v.* Hoek and A. C. Oudemans, "Recherches sur la quantité d'éther contenue dans les liquides," Utrecht, Observatory, *Recherches astronomiques*, 2 (1864), 1-71.

74 USS, "Correspondentie Oudemans." Oudemans to Curators, 17 Mar 1880.

75 USS, "Brievenboek Oudemans." Oudemans to unknown (in German), 11 Feb 1876.

76 USS, "Correspondentie Oudemans: Ministeries." Oudemans to Curators, 31 Jul 1882. In 1879 Oudemans managed to have a pavilion constructed for small instruments, but the director's residence *cum* classroom came only for Oudemans's successor in 1908. By this time, the KNMI had moved to De Bilt. A. W. Reinink and J. A. Schuur, *Bouwen voor Utrechts Universiteit: Architectuur en stedebouw binnen de stad* (Utrecht, 1985), pp. 78-81.

the geographical service of the Indies to concentrate on the islands of Java and Madura; only after completion of this work would the government ask the service, and Oudemans, to extend the mapping to Sumatra and the Outer Possessions. In the late 1870s, the field work required for the triangulation of Java was nearing its conclusion, the final reduction of the data could be anticipated, and the question of the Outer Possessions came up once more. After Oudemans's return to Utrecht, however, the geographical service shrank to a shadow of its former self. He left eight subordinates in place, but by 1880 only one among the group, his brother Jacques Adrien Oudemans, had not retired or succumbed—temporarily or permanently—to disease.[77] Work on the final triangulation of Java ground to a halt. In 1878 the naval commander at Batavia, Admiral Jacques Marie Isaac Brutel de la Rivière, wrote to Governor General Johan Wilhelm van Lansberge that the whole program could be placed back on track, and the mapping of the Outer Possessions would not have to be delayed, if Oudemans could be persuaded to supervise the final reduction and publication of the Javan data from his chair at Utrecht. Such a course seemed "not improbable" to the admiral.[78]

Oudemans was indispensable because of the peculiar way that pure science had become an essential feature of the mapping program. The geographical service had to determine the figure of the earth by making *absolute* latitude and longitude measurements at various points on Java, instead of merely referring all measurements to a marker at Weltevreden. The scientific aspect of Oudemans's survey had received naval and government sanction in 1865 after an intervention by the Amsterdam Academy of Sciences. In the 1870s the scientific part of the triangulation came to occupy the principal focus of the geographical service. Preliminary results argued against extreme precision in the triangulation, for

> strong local influences exist, either because of the attraction of mountain masses or because of irregularities in the dust distribution beneath the surface. Regarding these attractions one can only make an approximate calculation or, rather, an estimate, and regarding the irregularities beneath the surface no estimate at all. In East Java, where higher volcanos are present than in West Java, the situation is not any better. It cannot be known if the results will be useful for determining the general shape of the earth or whether they can serve for the calculation and determination of the attraction of mountain masses, but one can draw the following two conclusions: 1) it is unnecessary to carry out extremely precise measurements while undertaking the angular measurements in the triangulation, and, therefore [this surveying] will not cost much; 2) it will, on the contrary, be necessary to minimize the perturbing influences of the moun-

77 J. A. Oudemans in *NP*, *35* (1949), 193, as a *vendumeester* in Batavia.

78 USS, "Triangulatie." Naval Commander at Batavia to Governor General, 23 Feb 1878.

> tain masses by taking as many astronomical latitude measurements as possible at the north and east points of the triangulation network and by taking longitude differences. . . .[79]

With this understanding in mind, astronomical observations had received a good deal of attention. After Oudemans left the Indies, however, the government realized that a good map of Java did not depend on his ambitious program, and that, in any case, the astronomical measurements in hand could not serve for a general, scientific calculation.

In 1881 the colonial minister, Willem baron van Goltstein, dumped the matter into Oudemans's lap. The Utrecht astronomer would synthesize what had been done for Java. Oudemans would also train two naval officers to survey Sumatra.[80] The crafty astronomer turned these tasks to his advantage. He replied to Van Goltstein's entreaty:

> I do not have to tell Your Excellency how much I could object, I who am already charged with lecturing on required subjects here at the university and with directing an observatory. . . . However, if Your Excellency wants to trust me with the job (I know no one else whom I should want to see in charge of it) then I will not refuse.

Oudemans emphasized that he was acting in the interest of obtaining a scientific value for the figure of the earth as well as of publishing the results of the triangulation—a project that had thus far cost *f* 1.5 million. He would defer other research in favor of the project, which threatened to occupy "a large part of my spare time for years to come."[81]

Oudemans estimated that the calculations would take from four to eight years to complete, provided that he had two assistants. The astronomer demanded a high price for his services. He noted that his Indian pension had been cut from *f* 3600 to *f* 1100 because of his professorial salary. If he received yet another income, the pension would threaten to disappear. Oudemans asked Van Goltstein, then, for *f* 4700 per year, a figure that would be reduced to *f* 3600 by the new regulations restricting *cumulation*. This sum would be separate from Oudemans's expense account to cover hiring calculators, renting office space, purchasing stationery, and publishing the report of his work. He wanted to contract young scientists for the calculations at a rate that would come close to the salary of secondary-school teachers. Oudemans needed an immediate credit of *f* 4000 to cover these items, and he argued that he should have considerable discretion in accounting for the funds: "This way of doing things is least cumbersome; of course, it is based on trust, but this trust is an incentive for

79 *Ibid.* Pieter Adriaan Bergsma to Naval Ministry, 14 Apr 1881, citing a report by either J. A. C. Oudemans or his brother J. A. Oudemans.

80 USS, "Triangulatie." W. van Goltstein to Oudemans, 29 Aug 1881 and 19 Oct 1881.

81 *Ibid.* Oudemans to Van Goltstein, 19 Sep 1881.

the civil servant to be scrupulous in the spending of money." Oudemans proposed to set himself up at the head of a veritable empire. He was so confident of his ability to dictate terms to the colonial ministry that he dismissed the necessity of training naval officers for geodesy in the Indies. He urged the ministry to send future land surveyors to lectures at the Delft Institute of Technology given by an expert in the subject, Charles Mathieu Schols.[82] Van Goltstein awarded Oudemans *f* 3600 for a salary, but he balked—naturally enough—at providing a slush fund:

> The yearly amount of *f* 4000 for assistants, rent, etc. will not be placed at your disposal. For all expenditures... you will always have to submit an unstamped, advance declaration in duplicate to my department. You will have to enclose proof for advance payments that exceed *f* 3. The receipts should be submitted on stamped paper if they are for more than *f* 10.[83]

Oudemans would have to justify nearly every expense associated with the project.

Calculating the triangulation of Java became a vortex that sucked at Oudemans's energies. He managed a team of permanent and casual calculators, and he supervised printing of the topographical maps once the data had been reduced. Around 1894 he wrote to the colonial minister to justify having spent *f* 86,000 on drawing up and printing his results:

> If the personnel of the geographical service on Java in the years 1876-1880 had not been almost non-existent and if, as would have been normal, the personnel—engineers and assistants—had carried out the work on Java for salaries based on seniority, etc..., then the cost for the recalculation and the report would have been considerably more.[84]

Oudemans emphasized that he had effectively sacrificed his scientific life for the project. He was underpaid for his work, and "for that money I contracted to carry out a task that would tie me down for years and years, even during the summer holidays." Beginning in 1893, he no longer even received a salary for his efforts.[85]

Yet with the task came a number of rewards. Oudemans kept and trained talented students, hiring them as assistants on the project. Albertus Antonie Nijland, who in 1898 succeeded Oudemans in the chair of astronomy at Utrecht, cut his teeth on Javan latitudes and longitudes, carrying out "most of the difficult calculations" during the early 1890s.[86]

82 *Ibid.*, for Oudemans's proposals to the Colonial Ministry.

83 USS, "Triangulatie." Colonial Ministry to Oudemans, 7 Jun 1882.

84 USS, "Correspondentie Oudemans: Ministeries." Oudemans to Colonial Ministry, n.d.

85 *Ibid.* Oudemans to Colonial Ministry, n.d. Oudemans's final involvement with the triangulation of Java is given in "Triangulatie," *Encyc.*, *s. v.*

86 *Ibid.* Oudemans to Colonial Ministry, 25 Feb 1891.

Despite his desire to avoid training topographers for the Indies, Oudemans hosted and certified a number of naval officers at Utrecht.[87] Most importantly, Oudemans's continuing Indian involvement resulted in capital improvements to his observatory at a time when the government would not hear of providing substantial support for pure astronomy there.[88] Oudemans's finest acquisition from the colonial ministry was a platinum-iridium prototype meter. From the time of his repatriation, he belonged to the Dutch commission on furnishing the Netherlands with a standard meter.[89] As early as 1881 he observed that the meter used in Java (which he himself had delivered in the 1850s) was not calibrated directly against the one in Paris; neither had it been corrected for temperature variations. Oudemans urged that the Javan standard and the Dutch prototype both be sent to Utrecht, along with a comparison engine ordered directly from Paris, so that he could carry out the calibration. He proposed to set up the engine on his observatory grounds.[90] The platinum-iridium meter remained for years under Oudemans's care, on loan from the Indian government; he provided the colony with a glass copy.[91] To guarantee the accuracy of his calibrations, Oudemans asked for and received various instruments, such as a standard thermometer; the colonial ministry footed the bill.[92]

In 1898, on the occasion of his valedictory address at Utrecht, Oudemans looked back over his long career in astronomy. The Batavian period seemed, to him, a digression:

> Not that I neglected astronomy over there completely, for my job consisted in applying a good part of that science; but in other aspects, because of the circumstances in which I found myself, I became rather a dilettante. And a dilettantism of eighteen years does not promote a person who is practising a certain science.[93]

He agreed to succeed Hoek at Utrecht, he emphasized, because he had completed his task in the Indies, "to the extent that it could be completed." This statement conforms to the expectations of his *fin-de-siècle* listeners: Pure science, as practised in the universities, was noble and abstract—far removed from practical concerns and political pressures. In reality, however, Oudemans, in his last twenty-three years at Utrecht, managed little

87 *Ibid.* Colonial Ministry to Oudemans, 20 May 1886; Naval Ministry (Hydrography Department) to Oudemans, 4 Jul 1894; Oudemans to Naval Ministry, 9 Mar 1896.

88 *Ibid.* Oudemans to Naval Ministry, 2 Feb 1895.

89 Kuenen, *Aandeel van Nederland* [note 6], pp. 111-13, for Oudemans's participation in the commission.

90 USS, "Triangulatie." Oudemans to Van Goltstein, 19 Sep 1881; "Oudemans: Sterrewacht." Colonial Ministry to Oudemans, 23 Jul 1857 and 11 Jul 1857.

91 *Ibid.* Colonial Ministry to Oudemans, 11 Oct 1894.

92 *Ibid.*

93 Oudemans, *Afscheidsrede* [note 3], p. 32.

else except to negotiate his way though the corridors of power in search of funding for his observatory. The funding that he did obtain related to a practical project that, for more than forty years, sapped his spirit—the triangulation of the East Indies. Oudemans secured, in his own way, a permanent government commitment to astronomy at Utrecht.

## The Return of the Native

In the second decade of the twentieth century metropolitan astronomers turned to observational facilities in the Southern Hemisphere. Two developments in astronomy evoked this interest. First, the most exciting observational problems began to deal with the large-scale structure of the stars. Whereas the solar system could be explored from Northern-Hemispheric vantage points, gauging the measure of the universe required looking into the southern stars. Second, the rise of theoretical astronomy and astrophysics created a new division of labor: Theoreticians in metropolitan observatories required more data than could be supplied by their own telescopes. A scramble for southern observatories ensued, one following earlier imperialist offensives: France financed an observatory on Madagascar, Germany staffed related institutions in Samoa and Argentina, and private donors in the United States peopled astronomical satrapies in South America. Only the Netherlands, among the major colonialist powers, did not have a southern station.

By the 1930s, Dutch astronomers had risen to achieve international prominence both as observers and as theoreticians.[94] It would be difficult to imagine a country less well endowed with resources for star-gazing. Much of the Netherlands lies below sea level, and the country has no prominent hills; the Dutch skies are frequently obscured by clouds; and, despite a distinguished heritage of maritime commerce, the Netherlands never erected a naval observatory. Overseas developments played an important part in twentieth-century Dutch astronomy. The following pages address this role by considering the emergence of the finest astronomical observatory in the tropics and the career of its first director, Joan Voûte.

Joan George Erardus Gijsbert Voûte was born an eldest child in Madioen, Java, in 1879, his parents having married the year previously in Batavia. Joan's father Christoffel descended from a long line of devout Hugenot exiles. Following the custom of Dutch colonists, Voûte's parents sent him and his brothers to the Netherlands for their education. They lived with a Welsh grandmother and attended *gymnasium* in Amsterdam. Voûte then went to the Delft Institute of Technology, and in 1908, at the rather late age of twenty-nine, graduated as a civil engineer. At a time when practitioners of exact sciences flashed through university like blazing meteors, Voûte came to his life's work at a leisurely and measured gait. His

94 *Développement*, pp. 1-9.

mother, Maria Antoinnetta de Dieu Stierling, had died in 1896, and his father followed in 1904. Since arriving in the Netherlands, he had become a virtual orphan, although he did see his mother just before she died. An inheritance brought him creative leisure. While studying at Delft he discovered astronomy and the objects of his heart's desire. These were double stars. Upon leaving Delft, he went to the Leiden observatory to train as an astronomer.[95]

Voûte worked at Leiden for two years without pay before being named, in 1910, the "third observer" there. This lowest professional position in the observatory hierarchy (coming after the director, the first observer, and the second observer) had been created especially for Antonie Pannekoek in 1896. Voûte saw before him several paths to follow. He could make a career of observing and hope to rise to the position of first observer, as his superior Jan Hendrik Wilterdink had just done. Or he could leave the ladder at any point for other parts. In 1878 Jacobus Cornelius Kapteyn had resigned as second observer to become professor at Groningen; in 1906, Pannekoek had resigned as third observer to work in Berlin as an astronomer and socialist educator.[96] Voûte stayed at Leiden for five years. An ambitious observer would have begun to publish and would certainly have completed a doctorate in astronomy. This was not, however, Voûte's way. He married Anna Lorch and continued his craft out of love. By 1913 it should have become evident to Voûte that he would never rise to a commanding position in astronomy in the Netherlands. His sights turned outward. A mark could be made by observing double stars in the Southern Hemisphere. With money from his mother-in-law, he purchased equipment and set off for South Africa.[97]

Voûte headed for the Royal Observatory at the Cape of Good Hope, then under the direction of Sydney Samuel Hough. Voûte remained at the Cape for five years, carrying out his double-star survey of the southern skies. If his stars remained constant in their course, his domestic life careened from one extreme to another. He divorced Anna Lorch in 1915, the next year marrying Cornelia Wilhelmina Ulriche van Noorten. He divorced for a second time in 1917. With no regular position, and without support from wealthy in-laws, Voûte fell back on his own resources. These would probably have been sufficient for mere existence, but Voûte desired a place in the world of astronomers. In 1918 he wrote to Willem de Sitter, professor of astronomy at Leiden, asking to be rehired. The expatriate astronomer had heard that the director of the observatory, Ernst Frederik

95 AV and WS. D. J. K. O'Connell, "Joan George Erardus Gijsbertus Voûte," *Quarterly Journal of the Royal Astronomical Society*, *5* (1964), 296-7. Charles P. Olivier, "Double Stars," *Popular Astronomy*, *52* (1944), 417-28. A massive bibliography and typology is found in F. C. Henroteau, "Double and Multiple Stars," *Handbuch der Astrophysik*, *6*, ed. G. Eberhard (Berlin, 1928-36), 299-468. A recent handbook for observers is Paul Couteau, *Observing Visual Double Stars* (Cambridge, Mass., 1981).

96 Willem de Sitter, *Short History of the Observatory of the University at Leiden, 1633-1933* (Haarlem, 1933), pp. 44-5.

97 Information from AV and WS.

van de Sande Bakhuyzen, had died and that the first observer had quit; he asked De Sitter, as the senior astronomer, to think of him when reorganizing the observatory. Voûte no doubt knew that De Sitter had spent several years at the Cape under Hough's predecessor, David Gill.[98] When De Sitter took over, however, there would be no place for Voûte. The latter may or may not have had a realistic understanding of his chances at Leiden. He did turn most of his efforts toward being appointed lecturer in South Africa.

Voûte's campaign centered on finding a post in astronomy at the Afrikaans-language University of Stellenbosch, a local college elevated to university status in 1918. The university council decided to offer instruction in astronomy, but it balked at purchasing expensive equipment. Voûte asked De Sitter to help the cause "in word and deed" by lending the university a 7-inch refracting telescope and an old universal instrument. Once these were in place, he believed that donations would be forthcoming for bigger instruments. "It is difficult to convince the authorities" about the need for new equipment, Voûte emphasized. "Most of the council members are farmers and don't give a hoot about it. . . . But support from the professor at Leiden university and observatory, and lending instruments, will count for a great deal."[99] De Sitter saw no drawbacks to Voûte's plans: "The Leiden observatory shall with great pleasure support these efforts and sees it as its duty to do what it can during the first difficult years." He would look into lending the two desired instruments. If things turned out well at Stellenbosch, more equipment would be forthcoming.[100]

Voûte waited into 1919 for his lectureship. He then purchased land near Stellenbosch and resolved to erect a small observatory with his own 5-inch Zeiss camera. He asked De Sitter whether he could not himself be recipient of Leiden's astronomical largesse; he would be happy with a small salary and the promised equipment.[101] De Sitter gave serious consideration to Voûte's new plan. The Leiden curators, he wrote, had approved lending instruments to an institution in a friendly country, but it was not certain if they would agree to placing the instruments privately. Neither was the Leiden theoretician sure about entering Voûte on the payroll. Yet it might be possible, he thought, to appoint Voûte as an assistant in charge of the instruments. This would amount to at best *f* 2000 per year, with a small subsidy for purchasing photographical plates and erecting the telescopes. Since De Sitter had to present a budget to the curators in the near future and could not hope to obtain more precise information for Voûte before then, he decided to "take a gamble" and include provision for the arrangement in his proposals. De Sitter thought to name Voûte in charge of "a

98 LS. Voûte to De Sitter, 2 Jul 1918. Also AV.

99 LS. Voûte to De Sitter, 10 Aug 1918 and 26 Aug 1918.

100 LS. Voûte to De Sitter, 9 Jun 1918.

101 LS. Voûte to De Sitter, 12 Jan 1919.

branch" of the Leiden observatory.[102]

While Voûte sought a position at Stellenbosch, he looked to see what could be had at the Union Observatory in Johannesburg. His letters from the middle of 1919 appear frenzied, the writings of a man in crisis. Voûte did not want De Sitter to think that he was only interested in securing a position. "Yes, you know that I am doing it out of love for our science." He emphasized that "love for science as a motive is unthinkable in this country."[103] Stellenbosch remained unresponsive. It seemed to Voûte as if the first union astronomer at Johannesburg, Robert Thorburn Ayton Innes (a man who, like Voûte, had no doctorate), might "see his way clear to giving me a job and, with the instrument that the Dutch government is lending, carry out cooperative work" with Leiden. Voûte urged De Sitter to propose such an arrangement to both Innes and the astronomer royal at the Cape. Johannesburg was a more congenial site for the Dutch government than Cape Town, Voûte added, and the letter to Hough at the Cape would sweeten the proposition to Innes: "Between the two institutions reigns no friendship here. A letter to Hough would make Innes accept the plan because it would enable him to steal the honor away from Hough. Yes, it is deplorable that there is so much pettiness between scientists." In the middle of his strategy lesson, Voûte suddenly asked whether two junior-level observers still worked at Leiden, and in case they were leaving whether he could be appointed in their place. He then jumped to discuss the camera mounting that he envisaged for the cooperative South-African arrangement.[104] His letter was no way to address a patron and employer. Voûte was plainly distraught. His uncertainty impelled him to investigate working in the East Indies.

In June 1919, Voûte received an offer from Willem van Bemmelen, director of the Royal Magnetical and Meteorological Observatory at Batavia. Van Bemmelen would allow him to carry out photographical work with the 7-inch refractor, Voûte wrote to De Sitter. Voûte inclined to accept the post. Although Innes would willingly borrow instruments from Leiden, he could hire "only South Africans. . . who fought for their Empire."[105] At the end of July Voûte received his passage for the trip and a £ 60 stipend from the general secretariat of the East Indies, wired through the Dutch consul in Cape Town. His yearly salary would be *f* 5400, his position that of temporary scientist. It is unlikely that he knew about the exceptional nature of his appointment, or of the unusual arguments made to acquire his services.[106]

102 LS. De Sitter to Voûte, 5 Mar 1919.

103 LS. Voûte to De Sitter, 24 Mar 1919.

104 LS. Voûte to De Sitter, 21 Apr 1919.

105 LS. Voûte to De Sitter, 20 Jun 1919 and 17 Jul 1919. The second letter is penned on stationery belonging to the government land-surveying company of Smuts and Shaw.

106 BAN, Tzg. Ag. N° 33258/1919. Netherlands consul in Cape Town to Algemeene Secretarie, 23 Jul 1919, confirming telegram authorizing payments. Bt 19 Jul 1919, N° 49, authorizing

At the age of forty, then, Voûte received his first senior appointment in the world of science. For well over a decade he had devoted himself to astronomy as a private gentleman—a pattern that we shall see again in chapters three and four. Voûte's life story until this point suggests that he would be disinclined to submit to the routine of a government or academic institution. He returned home and lost little time in constructing the grandest Dutch astronomical observatory.

## Interests and Desires of the Metropolitan Astronomers

Joan Voûte arrived in Batavia eager to transform his position at Van Bemmelen's observatory into a full-time post for astronomy. Van Bemmelen, then close to retirement, had made the Royal Magnetical and Meteorological Observatory one of the world's centers for geophysical research. Having inherited a mandate to carry out meteorological and magnetical measurements from his predecessors, Van Bemmelen expanded the observatory's work to include seismology. At the same time he cut back on a previous commitment to study climatology, this subject being covered, in its practical aspects, at the botanical gardens in Buitenzorg. He turned his personal research toward upper-atmospheric phenomena. He generously hosted foreign scientists who passed through Batavia on their way to observe an eclipse or to circumnavigate the globe. Many of the visitors brought along sophisticated astronomical instruments, but Van Bemmelen could only look on in admiration. At the time that victors and vanquished met at Versailles, the Chinese Captain Lie Saay at Padang owned the largest telescope in the East Indies, a 7-inch Secrétan refractor that probably never saw serious service.[107]

Leiden's 7-inch refractor arrived at Batavia shortly after Voûte did, and the new man lost no time in making propaganda for his cause. Van Bemmelen, who by this time had begun to think of retiring to a teaching position in the Netherlands or the United States, urged Voûte to relate his astronomy to terrestrial magnetism. Voûte wrote to his colleagues in the Netherlands, asking them to have the Amsterdam Academy of Sciences pressure the "colonial ministry to ask the government in the Indies to consider the idea of carrying out astronomical observations." Voûte had in mind a modest institution, one tied to metropolitan observatories. The matter, he wrote to H. G. van de Sande Bakhuyzen, involved national honor, "because all other countries already have such institutions in their colonies."[108] Voûte was then forty years old, lacking a solid publications

payments. Naval Commandant in the East Indies to Governor General, 16 Jul 1919, for Voûte's salary; Van Bemmelen to Naval Commandant, 12 Jul 1919, for a strong recommendation.

107 On Lie Saay's telescope, purchased in 1884, J. Voûte, "Description of the Observatory," Bosscha Observatory, *Annalen*, *l*, pt 1 (1933), pp. A10-A11, A20, plate xi. LS, box 17, file 3. Voûte to Willem de Sitter, 28 Feb 1924, where Voûte guesses that the timepiece had never been used.

108 LS. Voûte to Van de Sande Bakhuyzen, 21 Nov 1919.

record, and without administrative experience. Here we see him urging the retired head of the Leiden observatory, his former employer, to begin a major publicity campaign for a completely new project.

By early 1920, Voûte had come to desire a new institution, one separate from Van Bemmelen's observatory. As he wrote to De Sitter, Van Bemmelen continually complained about the poor conditions for observing, even though they were far better than those at Leiden. If De Sitter and Kapteyn could only support his plans, then Voûte believed that the colonial government would come through with financing.[109] At this time Voûte imagined the observatory responding to both disciplinary and national needs: It would "compensate for the domination of observatories in the Northern Hemisphere and... complement them," and it would work closely with Leiden. He sought a middle road between the case of Greenwich and Cape Town, two observatories nominally under the British navy but in practice entirely independent of one another, and the case of Harvard and Arequipa, where the former completely controlled the latter. Voûte foresaw an independent director in the Indies who closely followed research programs set in Leiden: The colony would observe at the behest of the metropolis.[110]

Voûte's tentative plans soon translated into bravado. In April 1920 he wrote to Ejnar Hertzsprung, adjunct director of the Leiden observatory and effective chief during the period of De Sitter's convalescence from tuberculosis in Switzerland:

> I have obtained the cooperation of Mr K. A. R. Bosscha. His Excellency [the governor general] will also give financial aid. Mr Bosscha is the maecenas of science in the Indies. In a week we will discuss the furnishing of the observatory with the government secretary. The observatory, although in the beginning of modest proportions, will be a totally independent institution, [it will] however [remain] under the wings of the Leiden observatory.[111]

Voûte, a native son, had secured the collaboration of one of Java's richest men and a major philanthropist. He knew that Bosscha would place him in charge of the new institution. He wanted to smooth the path and obtain legitimation from the Netherlands. Voûte urged Hertzsprung to appoint Bosscha as Leiden's representative in the Indies: "This would be of great importance because of all the influence that Mr Bosscha has in this land." Voûte asked Hertzsprung to join with Kapteyn in proposing to Bosscha, by telegram, that he, Voûte, be named director of the new observatory. The audacity of such a request stemmed from the knowledge that astronomers in the Netherlands had no real choice in the matter:

109 LS. Voûte to De Sitter, 19 Feb 1920.

110 LS, box 17, file 3. Undated memorandum of Voûte's.

111 *Ibid.*

> Not that we are going to wait for the telegram and postpone holding our meetings and canvassing for the necessary money, but such activity will have to be done in secret. After the telegram it will become public knowledge.[112]

If Leiden wanted any say at all about the new institution, it would have to negotiate through Voûte. To conclude his letter, Voûte outlined plans for a double photographic refractor of 7-meter focal length. This jewel would be the finest telescope of its kind in the Southern Hemisphere and the largest in Dutch territory, an instrument well worth the attentions of the men at Leiden and Groningen. Voûte had no doubt that Bosscha would make everything work.

Faced with the momentous advance that Bosscha was facilitating, a development promising to place Dutch observational astronomy in a class with that of Great Britain and the United States, there would have been a tendency among lesser men in an imperial metropolis to chase after the prize in an undignified scramble. It is a measure of the shared feelings among Dutch astronomers that personal ambition did not sabotage attempts at forging a common strategy.

When Voûte requested Kapteyn's support for the new observatory, the Groningen astronomer wrote to Bosscha for a piece of the action. Lacking telescopes of his own, he had for many decades collaborated with observational facilities elsewhere, and he stood most to gain from an association with the new Javan institution. Kapteyn gave his support enthusiastically, but not without qualification. He emphasized that astronomy, in coming to address problems of the structure and evolution of the universe, had produced a subdiscipline of theoreticians who were not well served by observationalists. Kapteyn fervently desired that the new observatory provide a fruitful interaction between theory and observation. It would be ideal to process the photographical plates at Groningen, at his famous astronomical 'laboratory.' "Exactly such institutions as the astronomical laboratory in Groningen would be able to lend a helping hand." Kapteyn quickly added that he saw an important role, too, for the rival and better endowed observatory at Leiden: "Only through collaboration with Groningen and Leiden will the Indian institution obtain its *Leistungsfähigkeit*." Nijland's Utrecht observatory did not deserve mention.

In Kapteyn's view the metropolitan observatories had to "have a vote regarding everything undertaken in the Indies." Kapteyn applauded Voûte's desire to place the Javan observatory " 'under the wing' " of Leiden, but he wanted to see the power distributed more equitably: "In order not to place such a heavy load on the shoulders of the Leiden observatory," Kapteyn proposed a governing commission consisting of the director of the new observatory, the director and adjunct director of the Leiden observatory, the director at Groningen, and several of the principal bene-

112 *Ibid.*

factors. Kapteyn allowed that "in general it is more pleasant to have absolute power as a director," but modern astronomy depended "on the efficient production of material." Even George Ellery Hale, director of the world's largest observatory on Mt Wilson in California, had voluntarily agreed to share his power with theoretician advisors. Kapteyn realized that Voûte would be appointed director, and he approved "wholeheartedly of this choice." He also thought that Voûte's desire to carry out parallax measurements was a fine research program. It would require a telescope "with a focal distance of at least 8 or 9 meters and an aperture of not less than 60 centimeters." If such an instrument could not be procured, Kapteyn felt, then the parallax program had to be substituted with one that was less ambitious.[113]

Kapteyn concluded his letter to Bosscha by noting that he had sent copies to De Sitter and Hertzsprung, who would "react to it favorably or unfavorably." De Sitter, still convalescing in Switzerland, replied to Kapteyn almost immediately. He wrote that he himself had already sent a memorandum to Bosscha. De Sitter was not interested in a power-sharing arrangement with Groningen. In practice, he noted, the director on Java would make all local decisions, and so "it would be better to allow and recognize his power." To be effective, a mixed board of curators "should have power not only over the Indian observatory but also over the Leiden and Groningen observatories"; such an arrangement was plainly unacceptable. In view of the direction taken by the Dutch educational authorities, who had decided to favor the Leiden observatory over facilities at Groningen and Utrecht, De Sitter spoke from a position of considerable strength. Since Leiden would be able to obtain equipment and personnel more easily than its sister institutions, De Sitter suggested Leiden as the sole recipient of Voûte's parallax data. De Sitter above all favored "chaining the Indian observatory to the Leiden one." To bring this about he proposed that one commission dictate the activity of both the Leiden and the colonial observatory. The commission would be chosen by the directors of both observatories. De Sitter emphasized that such an arrangement guaranteed the second-class status of the colonial observatory, because in practice the curators of the University of Leiden would never allow the joint commission to determine policy at the metropolitan institution. Voûte, then, would handle the day-to-day activity of his observatory, but Leiden would determine the direction of his energies.[114]

Voûte sided squarely with Kapteyn against De Sitter. He began a memorandum on organizing his observatory on a small parcel of land in Lembang, near Bandung on west-central Java, by outlining his ideas on cooperation with the Netherlands. His observatory would be for observing. What he observed would be determined "in joint consultation with astronomers (especially theoreticians) in Holland." However, "the calculation of

113 LS. Kapteyn to Bosscha, 19 May 1920.
114 LS. De Sitter to Kapteyn, 24 May 1920.

the observation"—the reduction of the data—"should be given to someone else." The Netherlands had the trained personnel and the libraries necessary for reducing data. Voûte proposed a curatorial council on which would sit the Lembang director, the director and adjunct director at Leiden, the director at Groningen, and a small number of additional people from the Indies and the Netherlands. The director at Lembang would have complete control over the daily affairs of the observatory, and he would be responsible for apportioning time on the telescopes. He would, nevertheless, follow broad guidelines set down by the curators. Leiden and Groningen would have the privilege of requesting special observations, but they would be responsible for writing up and publishing the results. Leiden and Groningen would also be able to provide instruments for their own observers at Lembang. Half of the observatory's time would be devoted to the demands of the metropolis.[115]

Around the middle of 1920 Voûte asked Hendrik Antoon Lorentz, in his capacity as chairman of the appropriate section of the Amsterdam Academy of Sciences, to arrange for a letter of support to the government of the East Indies and a "word of appreciation" to Bosscha. Lorentz raised the question at a meeting of the academy and had a commission named to consider the matter. It was headed by H. G. van de Sande Bakhuyzen and filled by Johannes Paulus van der Stok (a predecessor of Van Bemmelen's at Batavia), Kapteyn, and, at Van de Sande Bakhuyzen's request, the corresponding member Van Bemmelen.[116] When De Sitter learned of this development, he sent instructions to Bakhuyzen in Leiden. He indicated that, even before Voûte arrived on Java, the thought had been for Leiden to erect an observatory in the Indies. The critical point concerned how to insure that Bosscha's new observatory became a satellite of Netherland's premier center for astronomy:

> It is of highest importance for the Leiden observatory that this cooperation, and hence the founding of the observatory, is pulled off, especially since, in that way, we can get our hands on observational data. For this to happen, we cannot say or argue that the new Indian observatory must do everything that Leiden tells it to do.

They had to insist that the observatory "remain independent of all other institutions." In this way, it would be completely separate from its principal rival on Java, Van Bemmelen's Royal Magnetical and Meteorological Observatory at Batavia.[117] Hertzsprung turned his master's opinion into a general proposal. There would be a division of labor between Java and

115 LS, box 17, file 3. Undated note on the organization of the observatory in Lembang, by Voûte.

116 *Ibid.* Van de Sande Bakhuyzen to Kapteyn, 5 Jul 1920, where the formation of the committee is detailed.

117 LS. De Sitter to Van de Sande Bakhuyzen, 20 Jul 1920.

Leiden, just as there was in Persian archaeology between the practical man who unearthed manuscripts and the expert in Europe who analyzed them. He proposed as a guiding principle: "observation in the Indies and analysis in Holland."[118]

All active astronomers had good reason to fret about the designs of Voûte's superior. Van Bemmelen had consistently lobbied against developing a major astronomical facility. In December 1919, Voûte explained to De Sitter that Van Bemmelen told him that "the best thing would be if we used all our power and financial support here for meteorology."[119] Van Bemmelen worried that the colonial ministry and the Indian government would support the new observatory to the detriment of his own institution. He continually emphasized the bad observing conditions on Java.[120] By the middle of 1920, he had succeeded in persuading The Hague, through his colleague and predecessor Van der Stok who was then at a commanding position with the KNMI, not to contribute to the astronomical venture. As Voûte reported to De Sitter:

> The government would certainly have done something for the observatory if we had not had opposition from Holland on the part of the minister, who is Van Bemmelen's mouthpiece. He [Van Bemmelen] has messed the whole thing up; proof can be found in how he tried to work on Van der Stok.[121]

Van der Stok expressed little sympathy with the prospect of astronomy on Java under the direction of Leiden. "I do not agree with the matter in general or even in particular," he began in a letter to Van de Sande Bakhuyzen. He did not want the Amsterdam academy to address the colonial government about the scheme. The Indies simply had no good location for the desired research program. The colonial government would be unresponsive to nationalist rhetoric, "to join in the race," and it would not respond to the fact that land and equipment came from the private sector. Even if Van de Sande Bakhuyzen, as chairman of the academy commission, decided in favor of writing to the government, Van Bemmelen's pessimistic view regarding the climate of Java had to be given priority.[122]

Voûte perceived the necessity of government support. In December 1919 he wrote to De Sitter that unless the government contributed to the cause "our position becomes a difficult one."[123] The colonial government was a many-headed monster, however, and even though the meteorologists

118 NYH. Typed draft, n.d.

119 LS. Voûte to De Sitter, Dec 1919, citing Van Bemmelen.

120 LS, box 17, file 3. Voûte to De Sitter, 19 Feb 1920: "Dr Van Bemmelen does not stop talking about the bad skies here with fine clouds."

121 LS. Voûte to De Sitter, 3 Jun 1920.

122 LS. Van der Stok to Van de Sande Bakhuyzen, 20 Sep 1920.

123 LS. Voûte to De Sitter, 12 Dec 1919.

firmly opposed the observatory, Voûte was able to mobilize support. The navy had just appointed a new commander for the Indies, Vice-Admiral W. J. G. Umbgrove, and Voûte urged De Sitter to contact him directly before he left Rotterdam for the East.[124] The new navy man had no special relationship with Van Bemmelen, technically his employee. Umbgrove realized that an observatory would come into being with or without his support, and that it would be best to have input regarding the matter. He waited until Van Bemmelen was in the Netherlands on leave during the middle of 1920 before asking Van Bemmelen's temporary replacement (and soon to be his permanent successor) at Batavia, Cornelis Braak, for a favorable report on Voûte's project. Braak emphasized that the Indies really did need an observatory, and that Voûte and his patron Bosscha had chosen a fine site for it. He recommended that the new observatory be entirely independent of the meteorological one at Batavia. Voûte's operation, in Braak's view, had to "limit its work exclusively to science"; the practical side of things would be left to Batavia. Even the determination of the official time of day, usually remanded to astronomers, would remain one of Braak's own tasks.[125]

Van Bemmelen and Van der Stok, meanwhile, as members of the committee of the Amsterdam academy, had to be placated. Van der Stok was the more formidable opponent. Kapteyn did his best to convert the meteorologist. He wrote frankly to Van der Stok: "Your opinion in this has caused me much sorrow, and I have the impression that if you were an astronomer you would look at the matter completely differently." Kapteyn indicated that he did not understand why, in Van der Stok's view, the academy should not support the realization of a cherished dream among Dutch astronomers. Kapteyn was all in favor of a location for the observatory in the Transvaal, but the means were not at hand for such a development. He urged Van der Stok to reconsider, for lukewarm support from the academy would do "more harm than good."[126] Kapteyn's solicitations produced the desired effect. The academy delivered a warm and vague letter of support for the new observatory, and it called on the Dutch government to provide "indispensable support and cooperation."[127]

By the middle of the summer of 1920, then, astronomers at Leiden and Groningen had reason to celebrate their imminent control of a major Southern-Hemisphere observatory. But they did not reckon with the enter-

124 LS. Voûte to De Sitter, 12 Dec 1919 (second letter).

125 LS, box 17, file 3. Cornelis Braak, report for the naval commander [Jun 1920].

126 *Ibid.* Kapteyn to Van der Stok, n.d. [addressee inferred]. Kapteyn might have known that, following Van der Stok's repatriation, he had once before undercut the authority of his successor at Batavia. In 1903 Van der Stok departed from the opinion of Simeon Figee and agreed with Melchior Treub that the Batavia observatory might well become part of a new departement of agriculture. H. H. Zeijlstra Fzn, *Melchior Treub: Pioneer of a New Era in the History of the Malay Archipelago* (Amsterdam, 1959), pp. 97-8.

127 *Ibid.* Undated, unsigned statement of support by the scientific section of the Amsterdam Academy.

prise of the observatory's principal benefactor.

## Machinations of an Eastern Maecenas

The pleasures of philanthropy attract many people. Some are genuinely uninterested in the day-to-day disbursement of funds; others enjoy guiding the factotum in charge of their foundation. Karel Albert Rudolf Bosscha was of the latter sort.

Bosscha came to his heart's desire legitimately. He was born in 1865 in The Hague as the son of the physicist Johannes Bosscha, Jr, professor at the military academy in nearby Breda and afterwards director of the polytechnical school in Delft.[128] Johannes junior endowed the Leiden observatory with a 19-cm Merz refractor, and in 1902 he told his son of his desire to see an observatory founded in the Indies. Bosscha's grandfather, Johannes senior, a professor of history and minister in the Dutch second chamber, had campaigned for the new Leiden observatory during the 1850s. From his mother's side, Bosscha inherited connections with the Indies. His mother, Paulina Emilia Kerkhoven, was the daughter of one of Java's oldest tea-plantation owners.[129]

As befitted a professor's son, K. A. R. Bosscha studied engineering at his father's polytechnic. He attended the laboratory of, among others, the physicist Heike Kamerlingh Onnes, and he belonged to a local astronomical association that went by the name of "Copernicus."[130] At the time of his final examination, however, he had a disagreement with one of his examiners. The outcome saw Bosscha leave without taking a diploma. In 1887 he steamed off for the plantation of one of his Kerkhoven relatives in the Indies. He floated around for nearly a decade, variously following his geologist brother Dr Jan Bosscha on a gold expedition to Borneo, working for a Java telephone company and advising the government, and trying his hand at cultivating tea. In 1896 his patron Eduard Julius Kerkhoven placed him as director of the Malabar tea plantation. In 1902 Bosscha's geologist brother abandoned Borneo for a neighboring plantation. Dividends from Malabar rose steadily from 9% in 1901 to over 80% in 1907, and the clever director diversified his holdings. As Bosscha's wealth increased, so followed his prestige. By the end of the First World War he had become one of Java's richest and most powerful men.

128 On the considerable accomplishments of Johannes Bosscha in physics: Kuenen, *Aandeel van Nederland* [note 6], pp. 102-9.

129 An excellent article has recently appeared on Bosscha and his observatory: K. A. van der Hucht and C. L. M. Kerkhoven, "De Bosscha-Sterrenwacht: Van thee tot sterrenkunde," *Zenit*, 9 (1982), 292-300. The authors are related to Bosscha, and they have made use of family archives to which I have not been granted access. I have supplemented their description with information from: "Ter Herinnering aan het 25-jarig jubileum van den heer K. A. R. Bosscha als hoofdadministrateur der Assam thee-onderneming 'Malabar', Pangalengan by Bandoeng," *Algemeen Landbouw-Weekblad voor Nederlandsch-Indië*, supplementary number (December 1920), especially the essay "Een Kwart Eeuw," by C. F. Bodde. See also "Bosscha," *BWN*, *s. v.*

130 "Sterrenkunde (de beoefening der) in Nederlandsch-Indië," *Encyc.*, *s. v.*

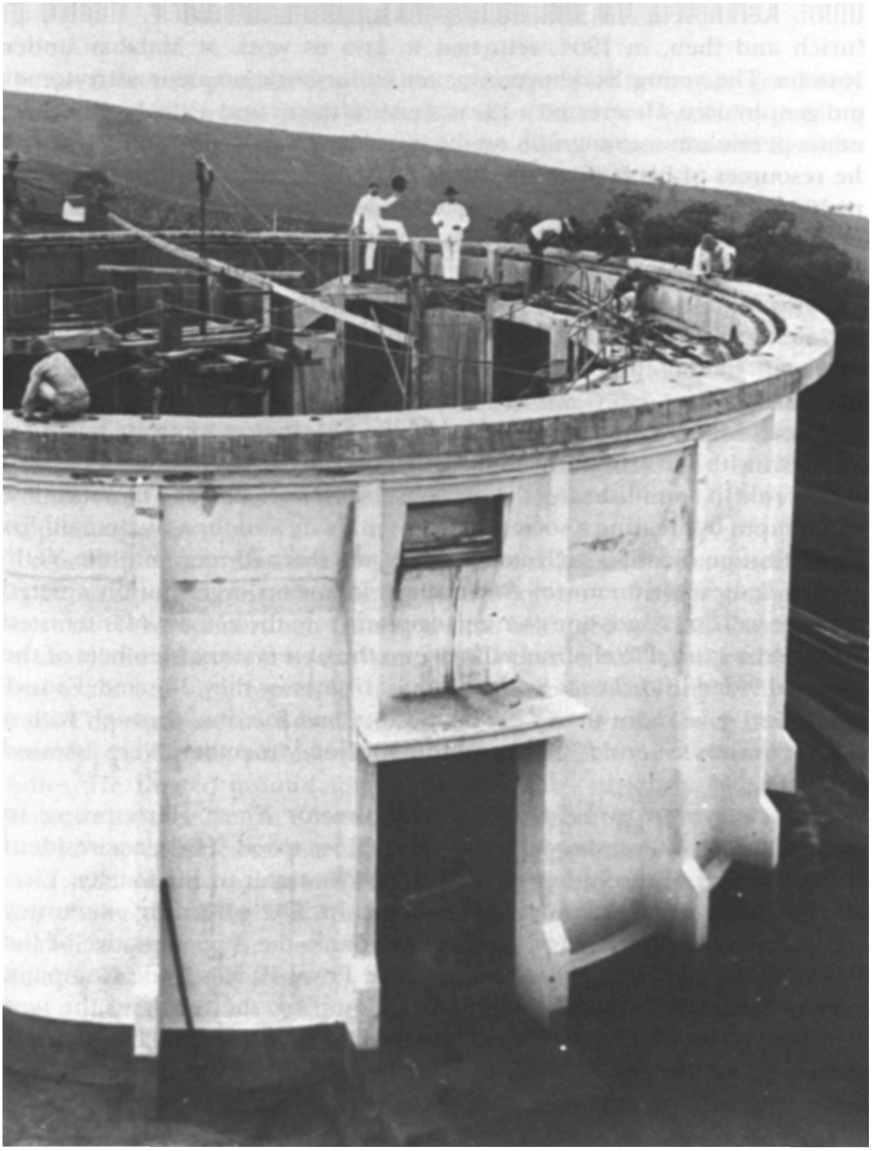
Bosscha's interest in exact sciences found a match in the mutual concerns of his first cousin, Rudolf Albert Kerkhoven, fourteen years his junior. Kerkhoven, the son of Bosscha's patron and uncle, studied in Zurich and then, in 1904, returned to Java to work at Malabar under Bosscha. The young Kerkhoven was an enthusiastic amateur astronomer and geophysicist. He erected a 13-cm Zeiss refractor and a 100-kg Wiechert astatic-pendulum seismograph on the tea plantation. Kerkhoven possessed the resources of his family's holdings; Bosscha, a bachelor with fingers in many profitable enterprises, gravitated to his close relatives. Together the two cousins decided to set up the finest observatory in the Southern Hemisphere. Bosscha believed that fate had ordained him this task. He wrote to De Sitter in 1920: "My late father, who knew how much I was attracted to astronomy, predicted a long time ago that I would become a rich man in the Indies and that I would then found an observatory there."[131]

Bosscha knew that he would never be able to compete in scientific authority with the astronomers at Leiden, in the event that they secured a central role in administering the new observatory. He decided to neutralize Dutch input by creating a society to act as midwife and then nursemaid for the institution. Bosscha collected patrons and learned men into the Netherlands Indies Astronomical Association. It was an organization created from the top down, not one coming together from the activity of interested amateurs; it existed to channel money into the observatory. Members of the society divided into classes by the amount of money they donated: Founding fathers gave more than *f* 10,000; donors had to come through with a *f* 500 initiation fee and *f* 100 per annum; ordinary members were assessed *f* 10.[132]

Bosscha wrote to Leiden's adjunct director Ejnar Hertzsprung in August 1920 to let him know exactly how things stood. The vice-president of the Council of the Indies was honorary chairman of his society; Vice-Admiral Umbgrove had honorary membership. The governing committee consisted of the president of the Javanese Bank, the representative of the Insulinde oil company, the director of the Royal Packet-Trade Company, the president of the Dutch Commercial Company, the rector of the new institute of technology at Bandung (which Bosscha had handsomely endowed), and Cornelis Braak at Batavia. Bosscha sat as chairman. His fellow philanthropist Kerkhoven served as secretary. The observatory

131 LS. Bosscha to De Sitter, 7 Sep 1920. BOC. Tettje Clay, wife of Bandung physics professor Jacob Clay, emphasizes Bosscha's bachelor state in a letter to her sister Hesje, 21 Jan 1921.

132 LS. Bosscha to Ejnar Hertzsprung, 16 Sep 1920. Financial and trading magnates put up between *f* 10,000 and *f* 500 each, although the major contributors were Bosscha and one or two other planters, such as F. H. Klein. The observatory ran entirely on their largesse until 1928, when the colonial government provided an annual subsidy of *f* 30,000. An informed guess would put the total amount from private sources, up to 1928, at *f* 1 million, although this amount includes a number of imponderables, such as gifts of land and equipment and subsidies for shipping and transport. J. van der Bilt, "Het Eerste Decennium der Bosscha-Sterrenwacht," *HD*, *29* (1931), 1-8.



3. Constructing the dome for Lembang's 60-cm double refractor. Joan Voûte raises his hat; on his left is K. A. R. Bosscha. Courtesy of Dr med. and Mevr. Jacques Walburgh Schmidt, formerly of The Hague.

would be located at Lembang, some 15 km from the town of Bandung with its handsome educational facilities. Bosscha had already seen to obtaining estimates for a telescope with focal length of 7 meters. He had even obtained H. G. van de Sande Bakhuyzen's personal library for his colonial astronomers.[133]

To name the observatory after Bosscha would be to seal the philanthopist's interest in the project. Voûte took it in hand to stroke Bosscha's ego. He wrote to Hertzsprung, urging a letter to this effect "to be signed by Prof. Bakhuyzen, Kapteyn, De Sitter, Hertzsprung, Nijland, Lorentz, and Kamerlingh Onnes." Voûte included a draft of the desired text.[134] De Sitter was sympathetic to the idea, but neither Kapteyn nor Hertzsprung agreed with him. "Certainly we wish to thank Mr K. A. R. Bosscha with all our heart for everything that he has done and to show our appreciation in some way," Hertzsprung wrote to Voûte, but Bosscha might turn out not to be the *principal* donor: "There will be all kinds of money lender (about which we do not know at the moment) who will have to be taken into account." Hertzsprung thought, with Kapteyn, that Bosscha's name might better be fixed to an instrument or a building.[135]

Donations were coming in from all quarters, and it seemed possible that, when the receipts were tallied up, Bosscha would not be the largest benefactor. Hertzsprung worked with Willem Cornelis Beucker Andreae, an administrator in the ministry of external affairs, to collect money in the Netherlands. Early in 1921 Hertzsprung thought that as much as *f* 500,000 might be required. The big telescope and dome came to around *f* 200,000, but this sum did not include buildings, other instruments, and the library. Hertzsprung noted that a new observatory could generally come up with buildings and equipment but that operating expenses, especially for publications, were another matter. To solve this problem the observatory founders envisaged an institution that would later be presented to the state.[136]

Having excluded the Leiden astronomers from a formal role in determining the new observatory's program, Bosscha and Voûte effectively gave Leiden a mandate to oversee purchase of the observatory's equipment. In August 1920, Bosscha opened a credit of *f* 5000 with Van de Sande Bakhuyzen for instruments, "from which you can withdraw money as you please," and began correspondence regarding construction of the big telescopes.[137] Bosscha wrote to ask Hertzsprung's advice about a site for the large refractor and how the telescope was to be mounted. He hoped to take advantage of the precipitous decline in the value of German currency to

133 LS. Bosscha to Hertzsprung, 2 Aug 1920; Bosscha to Van de Sande Bakhuyzen, 3 Aug 1920.

134 LS. Voûte to Hertzsprung, 27 Sep 1920.

135 LS. Hertzsprung to Voûte, 11 Dec 1920.

136 LS. Hertzsprung to Beucker Andreae, 18 Feb 1921. Identification of Beucker Andreae in *NP*, *29* (1943), 24.

137 LS. Bosscha to Van de Sande Bakhuyzen, 3 Aug 1920.

pay for instruments in marks: "If I receive a favorable answer from you, then I will transfer an amount of one million marks to a solid German bank." Bosscha thought that the Leiden astronomers might like to inspect what was going to the Indies, a possibility that he encouraged, but he worried over having to pay import duties once in the motherland and a second time in the colony.[138] Hertzsprung received complete latitude in negotiating with, and even in choosing, a German optical company,[139] although he declined to make any decisions without consulting Bosscha.[140] Hertzsprung glowed with the thought that Zeiss might deliver an objective of 60 cm with 10 m focal distance ("then we are not so close to the *konkurrenzfähige* boundary. . . and we astronomers can go to work doubly enthusiastic"), but he wanted above all to avoid prejudicing future funding from his colonial philanthropist.[141]

The Leiden astronomers deferred to Bosscha and Voûte when placing their orders.[142] Bosscha continued to shower the observatory with gifts. In September 1920, he paid for a 37-cm-objective visual telescope from Schmidt in Mittweida (the objective having been refigured from a lens used to calibrate a telescope of Karl Schwarzschild's at Potsdam), although he hesitated about covering, by himself, the cost of a 60-cm double refractor, which "will certainly go far above my head."[143] By early 1921, however, Hertzsprung reported that Bosscha "has presented us with a telescope of 10-meter focal distance and 60-centimeter diameter."[144]

## Imperial Dreams of the Leiden Observers

The Leiden astronomers saw Voûte as a small figure attached to Bosscha's train. After he returned from a European buying trip, he merited an honor of some sort. The professors blanched at the thought of awarding him a doctorate *honoris causa* from his alma mater; nor could he be received into a royal order of merit. Instead he became, in mid-1922, a corresponding member of the Amsterdam academy—a common and innocuous appointment bestowed by metropolitan corporations on their nationals who headed scientific institutions in the colonies. Voûte never availed himself of his academician's perogatives: No communication in the academy's annals bears his name. The affiliation had one objective: to help obtain money from the colonial government.[145] The Dutch astronomers wanted

138 LS. Bosscha to Hertzsprung, 21 Nov 1920. Neither Zeiss nor Bamberg would accept payment in marks. Hertzsprung to Bosscha, 3 Dec 1920.

139 LS. Voûte to Hertzsprung, 25 Nov 1920, where Voûte suggests that Hertzsprung go with Zeiss for both the lens and the housing of the big telescope.

140 LS. Hertzsprung to Bosscha, 3 Dec 1920.

141 *Ibid.*

142 LS. Hertzsprung to Voûte, 11 Dec 1920.

143 LS. Bosscha to De Sitter, 7 Sep 1920.

144 LS. Hertzsprung to W. C. Beucker Andreae, 18 Feb 1921.

145 NYH. Hertzsprung to Bosscha, 8 Jul 1922.

assurances of funding because they were thinking about joining with the Germans to observe the solar eclipse of September 1922, which would be visible from Christmas Island in the South Indian Ocean. Although Voûte received little thanks for his help from his metropolitan colleagues, the Germans arranged for him to receive an honorary doctorate from the University of Berlin.[146]

Three solar eclipses crossed the East Indies during the 1920s—in 1922, 1926, and 1929. Nothing suggests Voûte's marginality so much as his general abstention from Dutch activity surrounding their observation. Voûte felt tied to the construction of his observatory, and after 1922 he let roving amateur astronomers and government engineers involve themselves with the Europeans and Americans who used Batavia as a staging area for travelling to remote locations in the path of totality. Writing to thank the Dutch for assisting John A. Miller, the director of Sproul Observatory at Swarthmore who photographed the 1926 eclipse, Swarthmore College President Frank Aydelotte mentioned extensive help provided by R. A. Kerkhoven and the Netherlands Indies Astronomical Association; Voûte's assistance lay in his having travelled to Batavia "to arrange for certain details."[147] Voûte's isolation translated into near-invisibility among the local bureaucracy. For the colonial government, Voûte was Bosscha's wraith. When the general secretariat acknowledged support given by the governor of West Java for the German-Dutch eclipse expedition of 1926, thanks went to the director of the observatory at "Malabar (Bandoeng)."[148]

It is natural for talented men of learning to be reticent about affiliating themselves with new institutions in far-off places under unproven administrators. Such reticence, however, had little to do with the studied detachment that Leiden astronomers brought to Voûte and Bosscha's observatory. The two institutions corresponded correctly, both during the construction of the big double refractor and after its installation in 1928, but the exchange had no spirit. No Leiden astronomer—old or young—spent a substantial amount of time at Lembang in the 1920s. Lacking control over the observatory in the Indies, men at Leiden focused their attention on building a branch of the mother institution in South Africa. To understand the course of astronomy at Lembang, then, it is essential to consider the Dutch astronomical effort in the British Empire.

146 NYH. Bosscha and Kerkhoven to Hertzsprung, 11 Aug 1922. WS. Copy of Voûte's diploma, dated 25 Jul 1923, sent to Voûte by the Humboldt University on 28 Mar 1949. The Latin text reads: "Johanni Voûte observatori Lembangensis directori viro egregio qui cum Batvai [*sic*] Germanique coniunctis viribus expeditionem facerent in insulam cui nomen inditum est de die festo nati domini nostri sua industria omnia ita praeparavit perfecitque ut solis defectus qui erat die XXI. m. Septembris a. 1922 quam optime observari posset Philosophiae doctoris et artium liberalium magistri dignitatem et ornamenta, Die 25. m. Julii A. MCMXXIII honoris causa contulit."

147 BAN, Tzg. Ag. N° 27300/1929. Frank Aydelotte to U.S. consul in Batavia, 4 Oct 1926.

148 BAN, BGS 24 Apr 1927, N° 850. In the draft, Malabar—Bosscha's plantation—is crossed out and Lembang is substituted by hand. The lapse ignores the fact that land for the observatory came not from Bosscha but from the brothers Ursone. Voûte, "Description" [note 107], p. A9.

Dutch astronomers penetrated South Africa in a number of steps, and at each step their government weighed out its encouragement, to the extent that it did, in grams. The pattern is similar to the one present in the East Indies. Civil authorities required evidence of strong metropolitan interest and local financial support before they would consider funding permanent institutions of higher learning.[149]

The earliest long-term contact with astronomers in South Africa emerged at the University of Groningen. There, in 1878, twenty-seven-year-old Jacobus Cornelius Kapteyn arrived as professor of astronomy. The state, however, would not provide its astronomer with a telescope. Kapteyn contacted David Gill at the Cape, offering to measure the plates that Gill had taken of the southern sky. The resulting long-distance collaboration, between 1886 and 1896, brought Kapteyn's "astronomical laboratory" to world attention. He visited South Africa only after this project had essentially been completed.[150]

The second step taken by a Dutch astronomer in South Africa, while also a private venture, proceeded in a different manner, for its prime mover had a special temperament. We have seen that the protagonist, Joan Voûte, became a central figure in Dutch overseas astronomy during the first part of the twentieth century.

Having explored the possibilities of erecting a South African station under Voûte's charge, Leiden astronomers took the next, natural step when Voûte left the scene. De Sitter sounded out Yale's Frank Schlesinger about the possibility of receiving Leiden astronomers at Yale's southern station, projected for South Africa:

> I always have wanted to have opportunities of observing in the Southern Hemisphere. When you have your southern station, it may perhaps be possible to send one of our observers there, with an instrument, for a short time?[151]

The Leiden astronomers, however, did not want to use a large southern telescope by sufferance. In 1923 De Sitter arrived at a bilateral exchange agreement with Innes, whom he contrived to reward with an honorary Leiden doctorate. The snub might have been directed against Voûte, as could the terms of the entente. Facilities at Johannesburg and at Leiden were thrown open to astronomers from both institutions. The text of the agreement, appealing to the history of southern stations set up by north-

149 The general background of astronomy in South Africa is given in Richard Hugh Stoy, "Astronomy in South Africa," in *A History of Scientific Endeavour in South Africa*, ed. A. C. Brown (Cape Town, 1977), pp. 409-26; and Stoy, "Astronomy," in *Standard Encyclopedia of Southern Africa*, ed. D. J. Potgieter (Cape Town, 1970-76), *s. v.*, which is much the better treatment. Of a popular nature, but nonetheless useful, is Patrick Moore and Pete Collins, *The Astronomy of Southern Africa* (Cape Town, 1977).

150 "Kapteyn," *DSB*, *s. v.*

151 WAS. De Sitter to Schlesinger, 8 Jun 1922.

ern-European observers, stated:

> I—Astronomers from the Leiden Observatory shall have every facility to visit Johannesburg and to use the instrumental equipment of the Union Observatory for the purpose of extending to the Southern Sky the researches that they have been making over the Northern;
>
> II—It is understood that the Union Observatory shall not be responsible in any way for the salaries and travelling expenses of the visiting astronomers, nor for the cost of new instruments and apparat[u]s which they may require for their work;
>
> III—It is understood that the visiting astronomers shall have no independent rights in the Union Observatory and shall be subject at all times to the rules and regulations in force there, and that programmes of work shall be so arranged as not to interfere with the regular work of the Union Observatory;
>
> IV—In exchange the astronomers on the staff of the Union Observatory shall be allowed to enter the Leiden Observatory as research students for courses of instruction in theoretical and practical astronomy, and shall have every facility in using the resources of the Leiden Observatory, subject to the approval of the Director;
>
> V—It is understood that the salaries and travelling expenses of these astronomers shall be borne by the Union Observatory, and that they shall be subject, while staying at Leiden, to the general rules and statutes of the University of Leiden.[152]

Leiden received use of a major southern telescope, and Innes could send his students to drink deeply from the fount of Dutch wisdom.

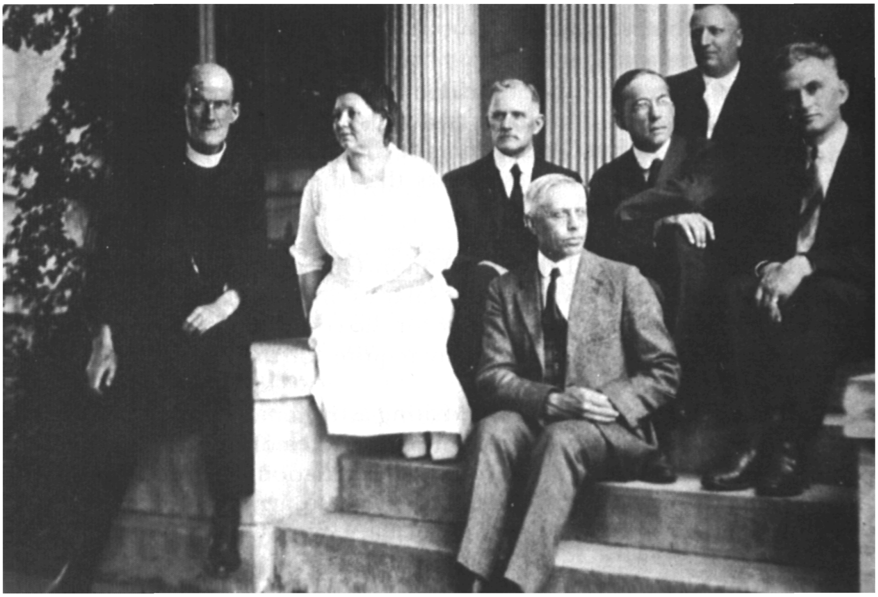
Ejnar Hertzsprung travelled to Johannesburg in October 1923, with the intention of spending half a year at the Union Observatory to study variable stars; he stayed for two-and-a-half years, and toward the end of his stay he used Innes's new 26-inch-aperture photographic telescope, which had been promised by the Transvaal government for a decade.[153] The men on central Java may have been the last to learn about the African adventure. When Bosscha sent Hertzsprung photographs of the official opening of the Lembang observatory, Hertzsprung replied with the news that he would soon be leaving for Johannesburg.[154]

Willem Hendrik van den Bos, who had obtained a doctorate in 1925

152 WAS. De Sitter to Schlesinger, draft of 1923 (in English).

153 *De Leidse Sterrewacht: Vier eeuwen wacht bij dag en bij nacht*, ed. Willem Bijleveld (Zwolle, 1983), p. 74.

154 NYH. Bosscha to Hertzsprung, 4 Jul 1923; Hertzsprung to Bosscha, 13 Aug 1923.



4. Southern-Hemisphere astronomers in Ann Arbor, Michigan, 1922. From left to right: E. F. Pigot, Mary McNeal Reed (Mrs Hussey), W. J. Hussey, W. C. Rufus, R. H. Curtiss, H. J. Colliau, R. A. Rossiter. Michigan Historical Collections, Bentley Historical Library, University of Michigan.

under De Sitter, followed Hertzsprung on a two-year appointment to work with Innes's big telescope.[155] He concentrated on cataloguing double stars.[156] His observations made an impression among colleagues at Leiden and in California, and Innes found the means to keep him on. Late in 1926 Innes wrote to the doyen of double-star astronomers, Robert Grant Aitken at Lick Observatory:

> I will retire at *66* and hope the Gov't will apppoint vdBos as Chief Assistant if [the first assistant Harry Edwin] Wood (as is expected) succeeds me. [Van den Bos] is not a Brit. subject, but that can be got over by appointing him temporarily. If he is *not* appointed then the 26-in. and double stars go to blazes.[157]

It easily came to pass. "Mr Wood has succeeded Dr Innes as Union Astronomer," Van den Bos wrote to Aitken early in 1928, "and I succeeded Wood as Chief Assistant, so that the 26½ inch and the Southern DSt. Office is in

155 LO. Innes to R. G. Aitken, 18 Feb 1925, for the contract and the assignment. W. S. Finsen, "Obituary: Willem Hendrik van den Bos," *Monthly Notes of the Astronomical Society of Southern Africa, 33*, 5 (1974), 60-1.

156 LO. Van den Bos to R. G. Aitken, 3 Apr 1927.

157 LO. Innes to Aitken, 27 Oct 1926. On Aitken: W. H. van den Bos, "Robert Grant Aitken," *Biographical Memoirs of the National Academy of Sciences, 32* (1958), 1-30.

my charge."[158] Wood, who encouraged "initiative, resourcefulness and enthusiasm" among his staff, gladly let Van den Bos chase double stars.[159]

Double stars became a hot topic in Southern-Hemisphere astronomy during the late 1920s. Van den Bos dealt cordially with Voûte, who had begun observing them at Lembang. He worked closely with Bernhard Hildebrandt Dawson, the American who stayed at La Plata in Argentina after William Joseph Hussey had brought him in during a short stint as director of the observatory there.[160] In 1925 Yale University erected a southern station at Johannesburg on the grounds of the University of Witwatersrand. Schlesinger was the senior partner behind the operation, and he along with permanent, on-site observers used the 26-inch South-African telescope—installed in a long, asymmetrical building—to extend his work on stellar parallaxes. Not to be outflanked by its traditional rival, Harvard University moved its southern station, in place at Arequipa in Peru since 1889, to Maselspoort, near Bloemfontein, some 370 km south of Johannesburg; John Stefanos Paraskevopoulos directed the transposed operation.[161]

Other American astronomers in South Africa had a different pedigree. In 1911 Hussey, director of the University of Michigan's observatory, had persuaded industrialist Robert Patterson Lamont to fund purchase of a 24-inch refracting telescope for use in the Southern Hemisphere. The original plan placed it in Argentina, where Hussey had a second observatory under his direction. Work on the telescope proceeded slowly. Hussey resigned as director at La Plata two years after the death of his wife in 1915. When Lamont's gift finally materialized, Hussey decided to locate it at Bloemfontein. He died in 1926, en route to supervise erection of the telescope. By 1928 the Lamont-Hussey Observatory, directed by Richard Alfred Rossiter, was scanning the skies for double stars.[162]

When the new telescopes came into service—two at Johannesburg, two at Bloemfontein, one at Lembang, and a reconditioned one at La Plata run by Dawson and the German director there, Johannes Hartmann—astronomers ran off to skim the cream of the southern skies. Double stars and variable stars were waiting to be bagged. The situation troubled Van den Bos, who had assumed Innes's task of publishing double-star catalogues and saw himself at the head of a central bureau for registering the observations of other southern astronomers. He wrote to Aitken in 1928: "I fail to see how we can have efficient cooperation without sacrifice of a large part of indiv. init. just as I fail to see how we can have a community

158 LO. Van den Bos to Aitken, 11 Jan 1928.

159 W. H. van den Bos, "In Memoriam H. E. Wood," *MN*, pp. 106-8, quotation on p. 107.

160 On Hussey and Dawson in Argentina, *CIES*, pp. 187-90, 196-205.

161 Generally, Stoy, *Encyclopedia* [note 149] and Moore and Collins, *Astronomy* [note 149]; J. H. Oort, "In Memoriam Professor Frank Schlesinger," *HD*, *43* (1945), 27-30. On moving the Radcliffe Observatory from Oxford to Pretoria, underway since the early 1930s but not completed until after the war, Moore and Collins, pp. 114-15.

162 "Hussey," *DSB*, *s. v.*; R. G. Aitken, *The Binary Stars* (New York, 1935), pp. 37-8.

without laws depriving the individual of a lot of his freedom." Van den Bos continued: "Your Cat is published, up to date, and the d-st men go for it like flies for the sugar pot." He wanted Aitken to be recognized by everyone as the double-star dictator who handed out assignments.[163]

Among his competitors, the Michigan astronomers turned out to be the most irritating for Van den Bos. He addressed a scathing letter to the Lamont-Hussey observers in February 1929. Their observations, he emphasized, had little value:

> I am a great admirer of Hussey's double-star work and have studied it closely and I cannot come to any other conclusion than that, if he could know that his cherished project were degenerating into a mad scramble for indiscriminate double-star discoveries, he would be gravely disappointed.

Hussey had set out two goals: a survey of the southern stars, and a thorough measuring campaign on new discoveries and on important and neglected pairs. Rossiter and his colleagues pursued neither goal well:

> Do not deceive yourself for a moment by hoping that the double-star experts (and they are the only men who know what they are talking about and entitled to judge) will give you much credit for the kind of work that is at present being done at the LHO.

Rossiter and company were observing too many faint doubles, in Van den Bos's view, those with magnitude higher than 9.0:

> A systematic survey down to 9.0, when done properly, thoroughly and completely gives us all we want for statistical investigations. A complete survey down to fainter magnitude limit can hardly be done thoroughly in a reasonable time, because the number of stars to be investigated gets too large (as I told you earlier, going from 9.0 to 9.5 CPD means doubling the work already) and we do not get enough nights of good seeing at a large telescope even in our favourable climate. . . . The time for fainter stars has not yet come.

The Bloemfontein observations included many stars of 10.0 and fainter, and as Van den Bos attempted to integrate them into his union catalogue of double stars, he had to "take the surgeon's knife and cut away all the cancerous growth of rubbish." Van den Bos urged Rossiter to suppress his desire for observing interesting double stars in favor of the general good:

> Do not be afraid that you will not make enough discoveries

163 LO. Van den Bos to Aitken, 23 Aug 1928.

> otherwise, there is still plenty waiting and it is not the number that counts, but the scientific thoroughness of the work. If I had not spent so much time on measurement and had not been so strict on my searches, I could easily have finished the 9.0 survey before you started (not in the way I want it done though) and robbed you of all the good pairs.[164]

Van den Bos thought that the Bloemfontein observers would send his "Jovian thunder" on to Hussey's successor at Ann Arbor, Ralph Hamilton Curtiss; he thought that only good would come from a frank discussion of the issue.[165]

As Van den Bos knew, prizes awaited individual astronomical entrepreneurs in the Southern Hemisphere. He recounted to Aitken how his coworker at the Union Observatory, William S. Finsen, discovered that Nova Pictoris was double.[166] The news went by cable to northern colleagues as they continued their observations: "It is a genuine case of fission. Most remarkable. We suspect something funny going on again but cannot make sure, are hoping for a good night." Van den Bos gloried in the possibility that the discovery would set theoreticians on their head: "I would not be surprised to find an entirely new cosmogony by [James] Jeans in the March or April nr. of the M[onthly] N[otices of the Royal Astronomical Society]." He qualified his fantasy with a more sobering evaluation:

> I do not think for a moment that all double stars or even an appreciable % of them resulted from novae. I think that gravitation *in this case* has been unable to win the fight against the splitting forces, gas pressures, radiation pressure, rotation and mainly the unknown force causing the nova phenomenon with its tremendous increase in volume.[167]

Finsen made the discovery because Dawson had written to ask for a verification of the nova. H. E. Wood, then an assistant astronomer, transmitted Dawson's request to Van den Bos on a Friday, when Finsen had use of the telescope. Van den Bos thought that such discoveries depended on chance and cooperation among southern observers. Previously, Dawson had identified a double star following Van den Bos's transmission of coordinates.[168]

164 LO. Van den Bos to Rossiter, Morris K. Jessup, and Henry Frederick Donner, 18 Feb 1929 (copy).

165 LO. Van den Bos to Aitken, 23 Aug 1928.

166 "Death of Dr W. S. Finsen," Johannesburg *Star*, 17 May 1979. I am endebted to Dr Charles Worsley of the United States Naval Observatory and Dr Jan Hers of Sedgefield, Republic of South Africa, for enlightenment on Finsen. Also: More and Collins, *Astronomy* [note 149], pp. 104-5.

167 LO. Van den Bos to Aitken, 4 Apr 1928.

168 *Ibid.*, and also: Van den Bos, "De Verdere Ontwikkeling van Nova Pictoris," *HD, 28* (1930), 390-2.

5. Southern-Hemisphere astronomers in Johannesburg, 1952. From left to right: Th. Walraven, G. Westerhout, Joan Voûte, W. H. van den Bos. Courtesy of Dr med. and Mevr. Jacques Walburgh Schmidt, formerly of The Hague.

By 1928 the Leiden astronomers had placed two of their minions at the eye of a major Southern-Hemisphere telescope, but they saw that Voûte and Van den Bos, although not uncooperative, were pursuing their own dreams and research programs. In the charged atmosphere of astronomical competition, De Sitter and Hertzsprung wanted a big, southern telescope of their own. They accordingly turned to the principal international granting agency of the interwar period, the Rockefeller Foundation. Beginning in 1927, they corresponded with the foundation's head Wickliffe Rose, and with two foundation janissaries, physicist Augustus Trowbridge and Princeton chemist Lauder William Jones.[169] In 1930 their ship reached port. The foundation granted $ 110,000 for the construction and operation of a double-astrograph refracting telescope to be manufactured by Grubb, Parsons & Co. in Newcastle, England, and the government of South Africa expressed interest in having the telescope at the Union Observatory. Before the money arrived, the Leiden astronomers established the Leiden Observatory Fund to attract donations and funnel the observatory's assets into one account. The Rockefeller Foundation was the main contributor,

169 LSA. Warren Weaver to De Sitter, 19 Jun 1934, where the history of the project is cited.

although the university provided *f* 800 per year. South Africa appeared neither in the foundation grant nor in the establishment of the observatory fund, but South Africa absorbed nearly all the fund's deposits.[170]

Payments for the telescope went out to Newcastle during the onset of the depression. Leiden asked the Rockefeller Foundation for supplemental increases to take account of unfavorable exchange rates and cuts in funding from the Dutch government, and Warren Weaver authorized the new payments.[171] The Dutch astronomers travelled to Newcastle in 1934 to inspect the objectives; by 1936 they voiced their displeasure with the product. The lenses absorbed much more ultraviolet light than would be suitable for their plans. They proposed to accept the English product at a discount and place a new order with someone else.[172] The Rockefeller Foundation balked at providing between £ 2000 and £ 3000 to order the lenses a second time from Grubb. Physicist and assistant director of the foundation's European office Wilbur Earle Tisdale wrote to Jan Hendrik Oort, associate professor of astronomy at Leiden, that "inasmuch as during the last several years our activities have been strictly limited to fields of biological interest," no more money would be forthcoming.[173]

Leiden decided to go with Zeiss in Jena. Oort informed Tisdale that Zeiss would sell the desired objectives at a great reduction—50,000 gold marks. In addition, Grubb agreed to cancel part of the contract, amounting to 40,000 gold marks. The remaining sum would come from the Leiden Observatory Fund, Oort continued. He asked the Rockefeller Foundation to pay the 40,000 gold marks to Zeiss instead of to Grubb; he specified two installments: 25,000 marks then and 15,000 to follow.[174] Before receiving a definitive reply from the foundation, Hertzsprung (who had become director of the Leiden observatory upon Willem de Sitter's death) decided to rent the substandard lenses from Grubb and personally supervise their installation in the buildings that were waiting at Johannesburg.[175] The arrangement would provide a temporary instrument for Hendrik van Gent, the Leiden astronomer who had been assigned to Johannesburg as Van den Bos's successor at the Leiden station.[176] In 1938 Hertzsprung

170 Bijleveld, *Leidse Sterrewacht* [note 153], p. 74. C. J. van Houten, "Stichting Leids Sterrewachtfonds 50 jaar; een overzicht van de activiteiten," mimeographed report (Leiden, 1980?). The reporting in Collins and Moore, *Astronomy* [note 149], p. 107, is inaccurate.

171 LSA. Adriaan van de Sande Bakhuyzen (a university curator) to European Director of the Rockefeller Foundation, 26 Oct 1933; Weaver to De Sitter, 19 Jun 1934.

172 LSA. De Sitter to W. E. Tisdale, 6 Aug 1934; A. van de Sande Bakhuyzen to Tisdale, 10 Jul 1936.

173 LSA. Tisdale to Oort, 18 Jun 1937; Tisdale to Van de Sande Bakhuyzen, 20 Jul 1937. On the evolution of the Rockefeller Foundation's policy direction: Robert E. Kohler, "Warren Weaver and the Rockefeller Foundation Program in Molecular Biology: A Case Study in the Management of Science," in *The Sciences in the American Context: New Perspectives*, ed. Nathan Reingold (Washington, D.C., 1979), pp. 249-93.

174 LSA. Oort to Tisdale, 1 Dec 1937.

175 LSA. A. van de Sande Bakhuyzen to Tisdale, 14 Apr 1939.

176 WAS. De Sitter to Schlesinger, 9 Aug 1927: "If Van den Bos is appointed at Johannesburg. . . , Van Gent will succeed him in his position at Leiden and will go to Johannesburg for us."

travelled to South Africa and inspected the lenses. In the spring of 1939 the foundation released a sum to the Leiden Observatory Fund and agreed to hold the final payment of *f* 1301 for Zeiss.[177] But Zeiss miscast the first blanks. A second casting succeeded eighteen months later. By then the war had closed in.[178] Early in 1941 Oort begged Tisdale to convert the unspent balance into dollars and presumably allow the Leiden astronomers to draw on it from a New York account; Tisdale replied that the funds had been blocked.[179]

Van Gent worked at the Leiden station and at the two other observatories in Johannesburg until his death in 1947.[180] Van den Bos, who had taken Wood's position as chief assistant when Wood succeeded Innes, followed Wood to the directorship of the Union Observatory in 1941. The Zeiss lenses survived the war in the neighborhood of Jena. In 1949, the Netherlands negotiated their release from the German Democratic Republic and installed them in Johannesburg.[181]

## Joan Voûte's Karma

The spirit of scientific inquiry can flourish in astonishing settings. The antechambers of a minister of state, the desolation of a small town, the rot and humidity of a tropical rain forest, and the cold of a subarctic winter—all, in their turn, have witnessed subtle research programs. Such a vast geography must not suggest, however, that the attentions of scientific inspiration are completely unpromiscuous: It is wrong to think that science is like love and, hence, money cannot buy it. Spent well, money can, in relatively short periods of time, transform cornfields into world-renowned laboratories. And munificent facilities naturally attract men and women of learning—flies to the honey-pot, slugs to the bait.

For the captain of a newly endowed scientific center, two problems assume paramount importance. First is the matter of securing funds for daily operations, as donors are understandably unenthusiastic about having their name attached to a new roof, septic system, journal subscription, or janitorial service. Second is the matter of visibility and international

In an unusually creative fiscal arrangement, Van Gent received Van den Bos's salary. De Sitter to Schlesinger, 19 Mar 1932: "Van den Bos is now acting as chief assistant to the Union Observatory on a salary of £ 600. But nominally he is still on the staff of the Leiden Observatory, and this salary is paid to the Leiden Observatory for the loan of his services. His Dutch salary, of course, is also paid to us, and we use it to have Van Gent at Johannesburg for us." Van Gent went on Rockefeller money soon thereafter. NYH. Hertzsprung to Van den Bos, 23 Nov 1932.

177 LSA. R. Letort (of the Rockefeller Foundation) to A. van de Sande Bakhuyzen, 18 Apr 1939.

178 Bijleveld, *Leidse Sterrewacht* [note 153], pp. 74-5.

179 LSA. Oort to Tisdale, 14 Feb 1941; Rockefeller Foundation to Oort, 20 Mar 1941.

180 J. H. Oort, "In Memoriam Dr H. van Gent," *HD*, *45* (1947), 159-60; W. H. van den Bos, "In Memoriam Dr Hendrik van Gent," *MN*, pp. 109-10.

181 Bijleveld, *Leidse Sterrewacht* [note 153], pp. 74-5; Van Houten, "Stichting Leids Sterrewachtfonds" [note 170].

circulation. The center must be open to new ideas and personalities, but it cannot allow employees to skim cream without milking the cows and churning butter. The architects of a new scientific institution must be clever about finding a sensitive and credible director. Hollow-headed administrators have run many finely appointed institutions into the ground.

Voûte assembled the instruments of his profession. By 1925 things had developed sufficiently to permit the beginnings of a research program. An engineer from the Bandung Institute of Technology who had helped construct the buildings provided an assessment for readers in the mother country. The observatory had a 19-cm-aperture visual refractor, used previously by Kaiser at Leiden, to which mounting was added a 15-cm Zeiss photographic ultraviolet triplet and a 12-cm photographic Zeiss-Tessar. It had a 9-cm Bamberg passage instrument. The 16-cm Secrétan refractor, donated to the observatory by the grandson of Lie Saay, was mounted parallel to a Dallmeyer photo-heliograph (which belonged to the Teyler's Stichting in Haarlem). There was an 11-cm Zeiss comet-seeker and, Bosscha's soon-to-arrive crowning jewel, the 60-cm double refractor—with one barrel for visual work and one for photography.[182]

Around the double refractor, the principal ornament of Dutch astronomy, rose a round, domed structure of reinforced concrete.[183] The floor beneath the telescope changed elevation, by means of an electric motor, to accommodate observers. Zeiss took nearly seven years to deliver the telescope, which arrived early in 1928.[184] The director fussed over the telescope for two more years until it worked to his satisfaction.[185] During calibration of the double refractor, Lembang's main instrument was a 37-cm Schmidt lens fitted into a tube made by Bamberg. The lens had been constructed with unusual specifications for Karl Schwarzschild at Potsdam and then, after Schwarzschild no longer needed it, refigured to make it more marketable; the refiguring, however, took away too much glass, and the lens bent as the telescope assumed different observing positions.

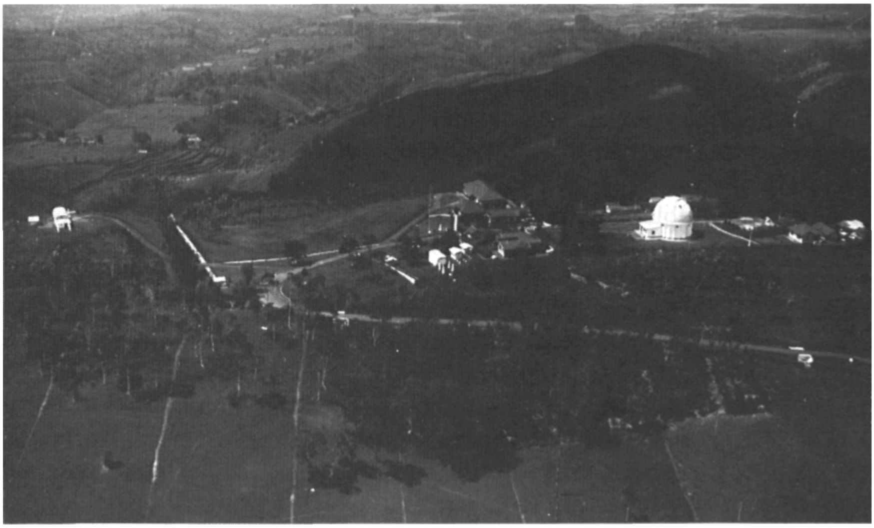
Even before he had opened all his windows on the sky, Voûte began thinking about assembling a staff. In 1923 he already expressed interest in attracting young Dutch astronomers to the observatory. The matter came up following a letter of inquiry written by the Utrecht *lector* in astronomy Jan van der Bilt. After receiving Bosscha's blessing, Voûte replied to Van der Bilt's chief, A. A. Nijland, to the effect that he would like to receive one person per year. He would provide lodging. He declined to specify other emoluments, but he indicated a stipend of *f* 200 per month for food and

182 J. Knol, "Eén en ander over de Bosscha-Sterrenwacht te Lembang," *HD*, *23* (1925), 221-35.

183 *Dévéloppement*, p. 9, where the double refractor is cited as the first large telescope controlled by the Netherlands.

184 W. Villiger, "Der 600 mm Zeiss-Doppelrefraktor der Bosscha Sternwarte Lembang auf Java," *Zeiss-Werkzeitung*, *3*, 3 (Dec 1928), 41-2.

185 Voûte, "Description of the Observatory" [note 107], p. A18.



6. Bosscha Observatory, 1924. The director's residence is in the complex at the center of the photograph. The Schmidt telescope is housed in the structure at the left.

clothing.[186] By early 1924, the Germans from the Berlin-Babelsberg observatory sought time on Dr Voûte's telescopes, but the director still had not funded his assistantship. He hoped to be able to match the stipend offered assistants at the Royal Magnetical and Meteorological Observatory in Batavia—*f* 300 per month.[187] Late in 1924 Voûte assured De Sitter that he was "still trying my darndest to get the necessary funds" to bring Jan Schilt, an assistant at Leiden who had just finished a doctorate at Groningen, to Lembang.[188] Schilt's Leiden connection would not have enamored him to Voûte, and the young Dutch astronomer pursued a successful career at Yale University, working with Schlesinger's South African station.[189] The first Dutch astronomer to spend time at Lembang was P. G. Meesters, an unaffiliated amateur from Halfweg. Meesters stayed on for a few months in 1925. Voûte expected him to help with "all practical jobs," but Meesters wanted only to look at the southern half of the celestial sphere.[190]

Antonie Pannekoek arrived as the second Dutch astronomer to use Voûte's facilities. Pannekoek, after having taken a doctorate in astronomy

186 LS, box 17, file 3. Voûte to De Sitter, 26 Jul 1923, where Voûte indicates the inquiry of Van der Bilt and his reply to Nijland.

187 *Ibid.* Voûte to De Sitter, 28 Feb 1924.

188 *Ibid.* Voûte to De Sitter, 7 Nov 1924.

189 Hertzsprung anticipated that Shilt would use the South African material from the beginning. NYH. Hertzsprung to Van den Bos, 31 Mar 1926.

190 LS, box 17, file 3. Voûte to De Sitter, 4 Apr 1925, for quotation. Meesters, "Visual Magnitude Observations of Nova Pictoris," *Bulletin of the Astronomical Institutes of the Netherlands*, *4*, N° 123 (1927). Meesters, *Mijn Sterrenwacht: Speurtochten langs het firmament* (Amsterdam, [1944]), pp. 48-51, on his short stay in Lembang; Meesters intimates a *contretemps* with Voûte.

at Leiden and serving as the third observer there for eight years, left the Netherlands to teach in German socialist schools. With the outbreak of war, he returned to conventional Dutch pedagogical institutions. In 1916 Pannekoek published a popular exposition of astronomy. The book quickly resulted in a 'call' from De Sitter to lecture as a privatdocent at Leiden. When De Sitter became director of the Leiden observatory in 1918, he sought to name two assistant directors—Hertzsprung for astrophysics and Pannekoek for positional astronomy. Revolution then burned a path across Europe, and the Dutch government in The Hague, under whose ultimate authority the university came, would not have a socialist boring at the observatory's walls. What the national government could not accept the socialist city council of Amsterdam, as the curators of a municipal university, welcomed. In 1919 Pannekoek entered Amsterdam as *lector* in astronomy. There he set up a modest astronomical 'laboratory' on the model of Kapteyn's Groningen. For six years he measured plates taken by other astronomers and explored theoretical astrophysics. In 1925 he became a member of the Amsterdam Academy of Sciences and had his *lectoraat* transformed into an associate professorship. At the end of the year he set off to observe the solar eclipse at Palembang. He spent five months at Lembang to take spectroscopic observations of the southern Milky Way.[191]

Pannekoek remembered Voûte as having kept a tight fist on the observatory finances because no large endowment covered day-to-day expenses.[192] When Pannekoek stayed at Lembang, the 60-cm double refractor had not yet been put into service. Voûte anticipated 1928 as the date when it would be prepared for serious observations, and Hertzsprung, despite his standoffishness, thought to spend some time with the new telescope for double-star work.[193] The man who next availed himself of Voûte's hospitality, however, was Paul ten Bruggencate, assistant at the Göttingen observatory.

Ten Bruggencate, the son of a Dutch jurist, was born in Arosa, Switzerland. He attended school in his native land, in the country of his birth, and in the nation of his cultural preference—Germany. He found his way to Munich in 1922 to study astronomy under Germany's astronomical doyen Hugo von Seeliger. The dean had by then essentially retired from the business of certifying acolytes, and responsibility for Ten Bruggencate's dissertation passed to Hans Kienle. The dissertation turned into a study of the main-sequence color-brightness relation. Ten Bruggencate continued his research under Kienle at Göttingen. After three years Kienle encour-

191 Antonie Pannekoek, "Sterrenkundige Herinneringen," in Pannekoek, *Herinneringen*, ed. B. A. Sijes (Amsterdam, 1982), pp. 229-74, on pp. 237-57. Pannekoek, "Die südliche Milchstrasse," Lembang, Bosscha Observatory, *Annalen*, *2*, part 1 (1927); Pannekoek, "Het Werk in Lembang," *HD*, *24* (1926), 1-5.

192 Pannekoek, *Herinneringen* [note 191], pp. 256-7.

193 L.O. Hertzsprung to Aitken, 19 Sep 1926: "There is a possibility that I will be invited to go to the Lembang Observatory, Java in 1928, when the 60 cm double refractor is supposed to be ready, in order to photograph double stars."

7. Paul ten Bruggencate (left) receiving Joan Voûte and his wife for an "official tea" on the verandah of Ten Bruggencate's residence at the Bosscha Observatory. Courtesy of Prof. Dr G. ten Bruggencate, Munich.

aged him to observe Delta-Cephei stars in the Southern Hemisphere—a program that Voûte found congenial. Ten Bruggencate spent 1926-28 in Lembang, published a stream of his observations and speculations, and entered as privatdocent at Greifswald in 1929. His accession to prestigious German institutions took place after 1933.[194]

Anticipating the completion of his big telescope, Voûte wrote to Hugo von Zeipel at Uppsala, whom he had met in Cambridge three years previously, about sending a replacement for Ten Bruggencate. In October 1927, Åke Anders Edvard Wallenquist, a young Swedish astronomer, accepted Voûte's invitation to use the large refractor.[195] Things did not work out as he had planned. He recalled:

> In the year 1927 I was invited by Dr Voûte to stay at this observatory for some years and here to undertake a photographic-photometric investigation of Omega Centauri and some other southern clusters in order to secure material for a

194 H. Kienle, "Paul ten Bruggencate, 24.2.1901—14.9.1961," *Naturwissenschaften, 49* (1962), 73-4; F. W. Jäger, "Paul ten Bruggencate," *Mitteilungen der Astronomischen Gesellschaft 1961* (Hamburg, 1962), pp. 21-4, plus bibliography; "Nachruf, Professor Dr Paul ten Bruggencate," *Zeitschrift für Astrophysik, 53* (1961), i-ii.

195 Wallenquist, "Over Het Leven en werken op de Bosscha Sterrewacht bij Lembang: Een halve eeuw geleden," *Moesson, 20,* 10 (15 Dec 1982), 6-9. Wallenquist recalls that he and Voûte initially spoke German. According to records in AV, in 1923 Voûte married Frieda Johanna Gertrud Elsbeth Adloff, a strong-willed woman of German extraction.

> closer study of the luminosities and the masses of the stars within these systems.

He arrived late in 1928. The refractor would not become available for use until 1930. While Voûte wrestled it into shape, Wallenquist used the misfigured Bamberg-Schmidt refractor and turned to observations that it could handle. Around 1930, he received a fellowship from Uppsala which would have allowed him to carry out his original research program in South Africa. Wallenquist applied to use the large reflector at the Lamont-Hussey Observatory in Bloemfontein. The Americans would not have him, and the Swedes would not let the money be applied against a trip to a California institution.[196] Wallenquist stayed at Lembang through the early 1930s, concentrating on southern galactic clusters and publishing widely. Before 1942 he was the longest-term foreign observer.[197]

Voûte welcomed visiting foreign observers, so long as they contributed to paying their own way. He wanted, nevertheless, to expand his staff by hiring two observers, one temporary and one permanent. The temporary observer, he wrote to De Sitter in 1927, would have to work on the programs already under way. The permanent observer, a Dutch citizen, could hope to carry out his own research. He asked De Sitter to contact Pannekoek, his "head agent" in the matter, and then to sign up an astronomer on a three-year contract. Voûte made his wants explicit: He required a gentleman who did not have a girlfriend.[198] By the time that he sent out a draft announcement for the positions, arrangements had become more generous. The confusing announcement read, in English:

> There are at present vacancies for two assistants at the observatory at the following terms: Free passage to and from Java on a 5-year contract; on year passage to Java free on a 3-year contract. If without a contract no passage refund will be made but full emoluments will be allowed irrespective of length of stay. The offer also extends to professional astronomers decisions of visiting this observatory as fellows to make certain researches, and for certain cases we are willing to make special arrangements. Applications to be directed to Prof. A. Pannekoek Amsterdam, from whom more particulars can be get.

Voûte offered *f* 300 per month and free lodging, with *f* 50 raises every eighteen months.[199] De Sitter declined to publish the announcement. He wrote to Voûte that he, Pannekoek, and Jacob Clay (the physics professor at

196 LO. Wallenquist to Robert J. Trumpler, 22 Feb 1931, where Wallenquist describes how he came to work at Lembang.

197 Wallenquist's Lembang publications are given in *Eeuw*, pp. 30-31. His first impressions in Wallenquist, "Det Nya Holländska Observatoriet, Bosscha-Sterrenwacht vid Lembang (Java)," *Populär Astronomisk Tidskrift*, 3/4 (1928), 169-82.

198 LS, box 17, file 3. Voûte to De Sitter, 12 Sep 1927.

199 *Ibid.* Undated announcement.

the Bandung Institute of Technology who was then on leave in the Netherlands) all felt that it would be best not to advertise for the positions. The call was "superfluous" for Dutch students. De Sitter had candidates whom he wanted to propose once they had completed a doctorate.[200] The Leiden astronomers sought to install one of their men at Lembang without the inconvenience of having him pass through an open competition.

Voûte recruited Egbertus A. Kreiken for the long-term contract. Kreiken had attended primary school in the Gironde, France, before finishing secondary school and university in the Netherlands, taking a doctorate in 1923 at Groningen. Kreiken, Kapteyn's student, was left academically orphaned by the death of his mentor in 1922. While earning his living as a schoolteacher, he served as temporary assistant to Hertzsprung and became, in 1926, privatdocent at the University of Amsterdam.[201] In his inaugural address he presented an elegant summary of the latest views on one of Kapteyn's pioneering interests, galactic astronomy.[202] He and his wife arrived in Lembang in 1928, and he immediately began to observe double stars.[203] Kreiken peppered the *Bulletin of the Astronomical Institutes of the Netherlands* with his data. Within two years he had come into conflict with Voûte, who wanted him to leave. Kreiken was "unusable for me," Voûte complained to De Sitter in 1930.[204] "The tone he assumed from the beginning is unheard of," Voûte continued in another letter, where he pointed to Kreiken's imminent article on astronomy for the *Encyclopädie van Nederlandsch-Indië*.[205] In 1930 Voûte drove Kreiken to accept a post at a secondary school.[206]

The controversy with Kreiken, whatever its real nature, was fanned by other winds. When the government effectively assumed control of the observatory in the middle 1920s, it provided *f* 30,000 yearly, or about half the operating expenses; the other half came from the Netherlands Indies Astronomical Association.[207] The onset of the Great Depression resulted in

200 *Ibid.* [De Sitter] to Voûte, 12 Dec 1927.

201 NYH. Greenwich Observatory to Kreiken, 27 Jan 1922. "Dr E. A. Kreiken Leaves Indonesia," *O. S. R. News: The Official Monthly of the Organizations for Scientific Research in Indonesia, 2* (1950), 166-8. Kreiken's dissertation was printed in 1922: *On the Colour of the Faint Stars in the Milky-Way and the Distance of the Scutum Group* (diss., Univ. Groningen, 1923). I infer his first name from an abbreviation, "Egb."

202 Kreiken, *De Melkweg: Openbare les gehouden bij de opening van zijn lessen als privaat-docent in de stellair-astronomie aan de Universiteit van Amsterdam op 19 januari 1926* (Groningen, 1926).

203 LMB. Pannekoek to Jacob Clay, 5 Nov 1928, where Pannekoek writes approvingly of Mrs Kreiken.

204 LS, box 17, file 3. Voûte to De Sitter, 8 Sep 1930.

205 *Ibid.* Voûte to De Sitter, 20 Oct 1930. Kreiken's article seems unobjectionable.

206 WAS. Schlesinger to Kreiken, 12 Oct 1929; Kreiken to Schlesinger, 16 Nov 1929, where Kreiken asks about posts in the United States. LS, box 17, file 3. Voûte to De Sitter, 3 Feb 1931. Kreiken went on to a distinguished career in science, spending part of 1936-37 at Mt Wilson. "Kreiken," *O. S. R. News* [note 201].

207 BAN, Bt 13 May 1933, N° 19, followed by Bt 26 Mar 1932, N° 14. Nederlandsch-Indische Sterrenkundige Vereeniging to Director of the Naval Departement, 12 Feb 1930, where the figure of *f* 30,000 for 1928 and also 1929 is provided. Bt 29 Sep 1928, N° 32 (located at Bt 6 Jan 1940, N° 58), authorizing *f* 30,000 for 1928, seems to mark the beginning of government funding.

retrenchment, and with Bosscha's death in 1928, Voûte lost his neighborly patron.[208] Late in 1930, ten years after the creation of the observatory, Voûte still did not have his large refractor in working order. Zeiss sent two specialists to rectify things. Voûte did not get along with the visitors: "The behavior of the engineer is so bad that I have complained about him to Zeiss. . . . They are looking for little things everywhere and do not notice the principal improvements made by us."[209]

Pannekoek remembered Voûte as an unusually contentious person who remained suspicious of theory and mistrustful of competitors.[210] The record is not as unambiguous as the recollection. As Voûte's big telescope came on line, he manifested ambivalence about inviting talented *Leiden* astronomers to share his instruments. Gerard Peter Kuiper, an assistant of De Sitter's, turned up in Lembang as a member of the Dutch eclipse expedition of 1928-29 and asked which instrument he might be allowed to use for photographing double stars. Voûte would offer him none and remained silent about access to the big refractor.[211] Yet when Wallenquist left Lembang for a docentship in Sweden in 1935, Voûte chose Kuiper to replace him. According to an official report, Kuiper, then at Lick Observatory, dithered before setting off for Lembang and in the end decided to stay in California.[212] Kuiper's superior at Lick, however, Robert Aitken, would not support him for a promotion and in any event thought that he would go to Java.[213] In 1935 Kuiper moved to become lecturer in astronomy at Harvard and then, later the same year, assistant professor under Otto Struve at Chicago's Yerkes Observatory.[214]

The actions of the young star from Leiden having confirmed Voûte's general feelings about Holland's premier university, Voûte gave the position to a German-educated astronomer, Gleb Victor Simonow; he sensed the bad feelings that the new choice would generate in Leiden.[215] The outcome weighed on Kuiper's mind. Early in 1936 he wrote twice to Hertzsprung to say what "a pity" that a Dutch astronomer, and especially one from Leiden, would not be going to Lembang. Kuiper blamed the

208 LS, box 17, file 3. Voûte to De Sitter, 8 Sep 1930.

209 *Ibid.* Voûte to De Sitter, 20 Oct 1930.

210 Pannekoek, *Herinneringen* [note 191], p. 256.

211 LS, box 17, file 3. Voûte to De Sitter, 28 May 1929.

212 Bandung, Nederlandsch-Indische Sterrenkundige Vereeniging, *Jaarverslag*, 1935, pp. 7-8.

213 NYH. Kuiper to Hertzsprung, 8 Mar 1935.

214 NYH. Kuiper to Hertzsprung, 17 Nov 1935. Kuiper tried to string Voûte along; he wrote to his patron in Leiden: "You already know that now I will certainly go to Lembang after remaining for a year at Harvard." NYH. Kuiper to Hertzsprung, 28 Mar 1935.

215 Voûte to Ten Bruggencate, 3 Dec 1935, where Voûte warns Ten Bruggencate that Simonow should not pass by Leiden on his way to Lembang because no one in Leiden yet knew that Simonow was taking Kuiper's place at the Bosscha Observatory, and Simonow would not receive help from the Leiden astronomers. I am grateful to Prof. Dr G. ten Bruggencate of Munich for sending me this letter. Simonow, son of a Russian engineer, attended the nautical college in Odessa and the University of Berlin; when Voûte tapped him, he had been a research student at the Berlin-Babelsberg observatory for several years. *Who's Who in Australia, 15* (1955), "Simonow," *s. v.* The spelling of Simonow's name in the Roman alphabet follows his choice.

circumstance on lack of interest among young men in the Netherlands. In his view, Simonow was "a routine man, without much perspective." The candidate fit the bill: "That is perhaps what Voûte, at least now, wants to have, pending a better candidate." Kuiper looked to the future and hoped that Peter van de Kamp would eventually succeed Voûte.[216]

Voûte hesitated to encourage independent work from his technical staff, such as occurred at many Dutch and British observatories. Beginning in 1926 Voûte enjoyed the assistance of a talented Dutch mechanic, A. J. Witlox, who in the early years published some observations. Witlox, who had the makings of a professional astronomer, became the nearly invisible force behind Voûte's enterprise; he earned the same salary as visiting astronomers, like Wallenquist.[217] As Voûte wrote to De Sitter in 1933 about the large refractor:

> It is completely fixed. I am very satisfied with it myself. The observations, though, still have to be carried out with care and attention, at any rate, the handling of the instrument. I do not let anyone except my technician touch it. He is also the one who took the parallax plates during my absence two years ago.[218]

It is easy to imagine that another administrator would have handled things differently. This circumstance should not suggest, however, that Voûte's decisions lacked a larger vision. He made use of Witlox to advance a collaborative venture with colleagues in the Southern Hemisphere. The story illustrates much about Voûte's ways and means.

Voûte watched his Dutch colleagues bring about what he had been unable to achieve in South Africa. He congratulated De Sitter on Leiden's obtaining the Rockefeller grant to set up a station in the "Eldorado for astronomers,"[219] and he expressed the hope that he might return to Johannesburg for a visit once the telescope was in service.[220] Voûte could afford to wish the Leiden astronomers well in their South-African adventure because he, with Witlox's expertise, was then setting up a satellite station of his own in Australia.

Voûte's Australian connection came through the Jesuits at Riverview, near Sydney. The Riverview College Observatory began in 1908 under Father Edward Francis Pigot, who had trained at Stonyhurst and had served as an astronomical assistant at the Jesuit observatory complex of

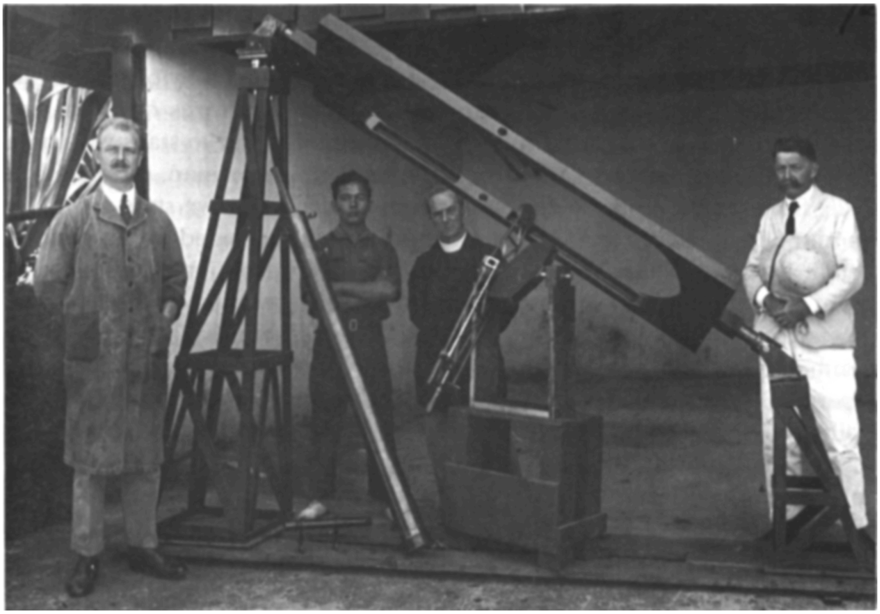
216 NYH. Kuiper to Hertzsprung, 9 Jun 1936, for citations and Simonow; Kuiper to Hertzsprung 14 Mar 1936, for the first condolence.

217 BAN, Bt 13 May 1933, N° 19, followed by Bt 26 Mar 1932, N° 14. "Begrooting voor het jaar 1930 voor de exploitatie voor de Bosscha-Sterrewacht." Witlox and Wallenquist earned *f* 3600, Kreiken as the permanent astronomer earned *f* 6000, and Voûte received *f* 14,400.

218 LS, box 17, file 3. Voûte to De Sitter, 11 Sep 1933.

219 *Ibid.* Voûte to De Sitter, 6 May 1930.

220 *Ibid.* Voûte to De Sitter, 11 Aug 1930.



8. A. J. Witlox (left), Rev. William J. O'Leary, and Joan Voûte preparing the Zeiss Astro-Triplet for Riverview, 1931. Jesuit Archives, Hawthorn, Victoria, Australia.

Zikawei near Shanghai.[221] Pigot restricted his research to seismology and geophysics for nearly twenty years, as these sciences probed the large-scale phenomena that were least expensive to investigate. He could think of undertaking astronomical work when, in 1922 he received a 7-inch refracting telescope as a gift from the father of a martyred soldier pupil of his. For several years he lobbied unsuccessfully to persuade Harvard to set up its new southern astronomical station in Australia, instead of South Africa. In 1926 he visited Voûte in Lembang on returning from the Pan-Pacific Science Congress in Tokyo. There Voûte outlined a joint project on variable stars, which seized Pigot's imagination.

Pigot died in 1929 from a chill contracted while surveying a site for a new Australian solar observatory. His successor, Father William J. O'Leary, found the means to implement the program with Lembang. The means resided with Voûte, who wanted to use identical photographical refractors at Lembang and Riverview for studying variable stars. O'Leary travelled to Lembang in 1931 to watch Witlox, following a design of Voûte's, set up a Zeiss Astro-Triplet on an English mounting.[222] O'Leary returned home with the new telescope, paid for by Voûte, and promptly began observing.

221 D. J. K. O'Connell, "Father Edward Francis Pigot, S. J.," *Studies: An Irish Quarterly Review of Letters, Philosophy and Science*, *41* (1952), 189-96, 323-32.

222 "List of Photographic Instruments at Riverview," Riverview College Observatory, *Publications*, *1*, 2 (1936), 32. A photographic record of the construction is kept in the Jesuit Archives, Hawthorn, Victoria, Australia.

By the time that he died, in 1939, he had taken about 8000 plates.[223]

Between 1931 and 1938, Voûte and O'Leary continually exchanged plates of variable and double stars, both those discovered by other observers and new ones. The Zeiss Astro-Triplets, with apertures of 6 cm and focal lengths of 27 cm, could rapidly be moved from star to star by a single observer. Robert Aitken, Lick Observatory's double-star man, estimated in 1929, for example, that he could measure only four to five stars per hour on his 36-inch telescope.[224] Increased mobility compensated for absence of detail. By 1939, when Voûte stepped down as director at Lembang and spent several months at Riverview, the stockpile allowed many hundreds of plates to be used in studying a single double star.[225] Voûte stayed at Lembang through most of the war. He continued observing under the Japanese occupation. His counterpart at Riverview, Father Daniel Joseph Kelly O'Connell (who succeeded O'Leary), did not see active military service. The results of their meticulous research appear in the second volume of the Riverview College Observatory publications series.[226] It is arguable that Riverview, with its modest equipment furnished in large part by Voûte, was the most advanced center of astronomy in Australia during the 1930s and 1940s. O'Connell's research there transported him to the directorship of the Vatican observatory.[227]

Although Voûte turned much of his attention toward Australasian coworkers, he continued to watch developments across the Indian Ocean in South Africa. He entered into a "pleasant relation," as he reported to De Sitter, with Van den Bos at the Union Observatory.[228] After several years of exchanging observations with Voûte, Van den Bos visited Lembang.[229] Voûte saw how, following a decade of waiting, Leiden's window on the southern skies came into being in 1938. Hertzsprung travelled to Johannesburg with his 33-year-old former student Aernout de Sitter, a son of Willem de Sitter's, to place the telescope in operation with lenses rented from Grubb. Hertzsprung returned to Leiden, confided the southern station to De Sitter, and thus fulfilled a dream of the young astronomer's late father.[230] He knew, however, that the real plum lay half a world away.

223 Daniel O'Connell, "Father William J. O'Leary, S. J.," Riverview College Observatory, *Publications*, *2*, 5 (1939), 1

224 LO. Aitken to Van den Bos, 18 Oct 1929.

225 For example, Voûte, "X Crucis," Riverview College Observatory, *Publications*, *2*, 3 (1946), 37-9, where measurements are made from 633 Lembang plates and 358 Riverview plates, taken between 1930 and 1937.

226 C. H. Hins omits discussion of astronomy at the Bosscha Observatory during the years 1942-46, mentioning only that no use would be served by going into it. *Eeuw*, p. 26.

227 George V. Coyne and Martin F. McCarthy, *Daniel Joseph Kelly O'Connell, S.J.: In Memoriam* [Vatican, 1982?], 4 pp. *separatum*.

228 LS, box 17, file 3. Voûte to De Sitter, 11 Sep 1933.

229 *Jaarverslag*, 1935 [note 212], p. 9. Van den Bos, "Een Maand op de Bosscha Sterrenwacht," *HD*, *34* (1936), 294-7.

230 WAS. Willem de Sitter to Schlesinger, 9 Aug 1927. De Sitter comments on Dutch observers who might be coming on line for Schlesinger's southern station, concluding: "And then, in the far future, there is my own son Aernout."

Just at the time that Hertzsprung was setting his southern station in order, he received a letter from the directors of the Netherlands Indies Astronomical Association, who acted as curators for the Bosscha Observatory. The directors indicated that Voûte would be retiring in 1939 when he reached age sixty. He would travel for a year and then return to reside at Lembang for two years while writing up his data. During this period he would retain the title of observatory director but none of a director's powers. These powers would be held by an acting director and heir apparent. The curators asked Hertzsprung to supply candidates.[231] He named four: Van den Bos; Pieter Theodorus Oosterhoff, a *conservator* at the Leiden Observatory; Kuiper, at Yerkes Observatory; and finally Aernout de Sitter.[232] The Bosscha Observatory went to De Sitter. Hendrik van Gent succeeded De Sitter at Johannesburg, and Van Gent claimed the young Leiden astronomer Willem Christiaan Martin as an assistant. In this way Hertzsprung came to have control over two major southern observatories.[233]

Hertzsprung's triumph was brief. Scientific contact effectively ceased with the German invasion of 1940, and we have seen that, in any case, the Zeiss lenses did not arrive in South Africa until after the war. A year after the Netherlands fell, Martin joined De Sitter at Lembang. There De Sitter, Martin, and the mechanic Witlox were soon mobilized. All three became prisoners of the Japanese, and all three died in concentration camps.[234] Voûte also went into internment, but he returned to the observatory at the request of the Japanese astronomers who took charge in 1943. There he carried out observations of double stars with the tacit approval of the *chargé d'affaires*, Masasi Miyadi.[235] Under the Japanese adminstration, Voûte measured 11,000 pairs, first with the 37-cm telescope and then with the largest one, which the Japanese remounted. During this time, the Japanese ran the time service and the longitude-variation service. The native Javanese expelled Voûte from the observatory grounds on 8 October 1945. A portion of his observations eventually appeared in print.[236]

231 NYH. Directors of the Nederlandsch-Indische Sterrenkundige Vereeniging to Hertzsprung, 10 Jun 1938.

232 NYH. Hertzsprung to directors of the Nederlandsch-Indische Sterrenkundige Vereeniging, 20 Jun 1938.

233 Bijleveld, *Leidse Sterrewacht* [note 153], p. 74, which is not clear about the sequence at the southern station. J. H. Oort, "In Memoriam Dr A. de Sitter," *HD*, *44* (1946), 33-4; P. T. Oosterhoff, "In Memoriam Willem Christiaan Martin," *ibid.*, p. 34; J. H. Oort, "In Memoriam Dr H. van Gent," *ibid.*, *45* (1947), 159-60. I infer that Van Gent was in charge after De Sitter's departure.

234 *Eeuw*, p. 26.

235 The history of the Japanese administration at Bandung is given in Miyadi, "Missing Data of Observations in Java," *Astronomical Herald*, *68*, 10 (1975), 319-21 [in Japanese]. I am grateful to Prof. Dr Bambang Hidayat for sending me this article and a translation of it by Naonobu Sato. Allegations of Japanese mismanagement, just as those questioning Voûte's patriotism, seem groundless.

236 NYH. Hendrik van Gent to Hertzsprung, 8 Dec 1945, where Voûte's astronomical work under the Japanese is described. Voûte discusses his observations in the postwar Riverview publications; his extensive double-star measurements appear as: "Measures of Double Stars, War-

Precedent for Voûte's activity under the Japanese may be found in German geophysics in the shadow of New Zealand administrators on Western Samoa during the First World War.[237] According to his guiding vision, pure learning transcended the hazard of political domination—be it by Asian invader or European professor. Voûte resisted becoming an affiliate of Leiden astronomy, staffing his observatory with international talent and undertaking independent projects. The Bosscha Observatory radiated Dutch presence precisely because Voûte refused to become an errand-boy for metropolitan academics or colonial agriculturists. The colonial regime was well served by the karma of its principal astronomer.

Series, Made at the Bosscha Observatory Lembang (Java)," *Journal des observateurs* (Marseilles), *78*, 6 (1955), 109-163, with a descriptive introduction.

237 *CIES*, pp. 101-17.

3

# Islands of Earthly Wonders

## The Decision to Gather Geophysical Knowledge

A sophisticated understanding of the weather, the tides, tectonic movement, and the terrestrial magnetic field requires detailed evidence accumulated at many distant locations over long periods of time. Major innovations in most branches of the exact sciences have occurred within a pleiade of select institutions of higher learning. Not so in geophysics. Unravelling the structure and movement of large air masses, the lithosphere, and the earth's magnetic field has depended on the regular and attentive measurements of dedicated observers located, for much of their career, at institutions of higher learning half a world away from the centers of pomp and ceremony in their discipline. It would be difficult to ignore the knowledge assembled, over the preceding century, by hundreds of men and women at Zikawei, Phu-lien, Tananarive, Bouzaréah, Ksara, Apia, and Riverview, institutions that since the 1940s have suffered through wars, revolutions, and urban sprawl. Among all the geophysical observatories beyond the North-Atlantic World, the one with the most impressive record of research publications emerged in the Dutch East Indies.

Charles Ferdinand Pahud became governor general of the East Indies in 1856. Before taking up residence on Java, he travelled through Germany. There he met with Alexander von Humboldt. Decades earlier, Humboldt had campaigned for a world-wide network of stations to monitor terrestrial magnetism. He urged the new Dutch governor to carry out magnetical and meteorological surveys of the colony. Correspondence ensued among Pahud, Humboldt, and the British meteorologist at Kew Observatory, Edward Sabine. Humboldt suggested establishment of "a single magnetical station in Batavia or its surroundings," with meteorological stations to be located nearby. Instruments at the stations were to be "identical with those of the English stations," and the staff at Batavia had to be as large as the ones in place at Madras, Cape Town, and Singapore.[1] Sabine offered to

1 USS, "Correspondentie Oudemans: Ministeries." Oudemans's notes regarding cabinet documents. Oudemans used these notes in constructing his obituary, "Levensschets van Dr P. A. Bergsma," *Amst. Jaarb.*, 1882, pp. 98-152, which is the standard account of the foundation of the Batavia observatory. On Humboldt and his schemes: Lotte Kellner, "Alexander von Humboldt and the History of International Scientific Collaboration," *Scientia*, *54* (1960), 1-5; Sydney Chapman, "Alexander von Humboldt and Geomagnetic Science," *Archive for History of Exact Sciences*, *2* (1962), 41-51; Kurt-R. Biermann, "Alexander von Humboldt als Initiator und Organisator internationaler

lend Pahud the required instruments. Then the project became an academic football.

*The Academic*

The Utrecht professor C. H. D. Buys Ballot got wind of Humboldt's scheme and dunned the Dutch colonial minister, Pieter Mijer, proposing a network of stations under the stewardship of a central office in Batavia which would be in contact with his own meteorological institute. In this way, he realized, he could establish a veritable empire in geophysics at little cost or personal anxiety. Buys Ballot's interest here is identical with the interest expressed by the Leiden astronomer Frederik Kaiser for carrying out longitude determinations of the Indies: An enormous project of practical dimensions (respectively, the preparation of geographical and magnetical charts) would serve to provision a metropolitan empire in pure science.[2] Government ministers responded in part to the useful end claimed by the projects. They also provided funding in the hopes of furthering the spiritual ends of science, which they understood to be an international undertaking. By supporting this kind of science, the Netherlands would appear before the world as a civilized nation and would strengthen a claim to ownership of the colony to be surveyed. International cooperation, from this point of view, is dispassionate in conception and selfish in execution.

More than any other modern nation, the Netherlands has been outward looking, assimilationist, and tolerant. In the nineteenth century, Dutch scientists took extraordinary care to familiarize themselves with the work of colleagues who published in English, French, and German. They travelled widely in Europe, bringing back the best of what they saw and turning it to their advantage. They came to international, cooperative schemes forthrightly and executed their tasks assiduously. They competed as individuals against mighty engines of research which had emerged in centers like Berlin, Paris, and Cambridge; their situation at the intellectual crossroads of Europe regularly led to major innovations and discoveries. To its great credit, the Netherlands experienced no national mobilization of scientific cadres like the ones that bled off scarce resources and choked research in Britain and France. Unlike the situation in neighboring countries, prominence in the Netherlands came following internationally recognized accomplishment.[3]

Zusammenarbeit auf geophysikalischem Gebiet," in *Human Implications of Scientific Advance: Proceedings of the XVth International Congress of the History of Science, Edinburgh, 10-19 August 1977*, ed. E. G. Forbes (Edinburgh, 1978), pp. 126-38, and the sources cited there. Dutch researchers are entirely absent from Robert P. Multhauf and Gregory Good, *A Brief History of Geomagnetism and a Catalog of the Collections of the National Museum of American History* (Washington, 1987) [*Smithsonian Studies in History and Technology*, N° 48], a source that focuses on the nineteenth century.

2 On Kaiser and the East Indies, and on Buys Ballot, see chapter two.

3 The main lines of Dutch participation in the international life of science during the

For Buys Ballot in 1857, the magnetical survey of the Indies reduced to one question: Who would take charge of it? In the eyes of the Dutch colonial ministry, which would foot the bill, the obvious choice had already been hired. Just before he shipped out to the East Indies as the chief engineer of the geographical service there, astronomer J. A. C. Oudemans, suddenly found himself asked to assume responsibility for organizing Buys Ballot's colonial magnetical observatory. Oudemans expressed reservations about taking on the task in a letter to Colonial Minister Pieter Mijer, written while he toured Germany in preparation for travelling to Batavia. "Nobody will deny the importance of a meteorological and magnetical observatory in Batavia," such being the two tasks of the institution envisaged by Humboldt and Buys Ballot, "and that this meteorological station could be of great importance for science and shipping." Oudemans had recently seen the correspondence between Humboldt and Pahud, as well as a letter of Sabine's, on the matter. Humboldt had also personally urged him, as the colonial ministry was now urging him, to "undertake construction of the meteorological and magnetical stations." Alas, Oudemans lamented to the colonial minister, the question had been raised merely days before his departure. He was "not well prepared" for the new task. He knew little about meteorology, and he had time to correspond neither with Sabine nor with instrument makers. "If you and Baron von Humboldt still insist on constructing such a station in Batavia," Oudemans wrote, "then I have to request that Your Excellency put someone else in charge of it." The young astronomer suggested that the minister contact his rival at the meteorological institute in Utrecht about a suitable director. Selection of personnel for the project, in any event, had to precede construction of a specialized observatory. Oudemans concluded: "For the sake of the geographical service, of which I have been put in charge by you, please ask someone else to build the observatory."[4]

Buys Ballot, undeterred by Oudemans's refusal, continued to plan for an empire in geophysics. He informed the colonial minister that the observations made so far in the Indies (here he alluded to the magnetical survey of the area between Madras and Borneo undertaken by Charles M. Elliot of the Madras engineers in the late 1840s) were untrustworthy.[5] The Utrecht meteorologist urged higher salaries for observers. He proposed to visit Sabine himself. Then he indicated that the existing stations in the Indies would be kept in service, and he listed them: Buitenzorg, Tjilatjap, Banjumas, and Banjoe Wangi, in a string across Java; Padang and Palembang across south-central Sumatra; Makassar in southern Celebes; Amboina, off southern Ceram; Decima; and Makaai. New stations would be

nineteenth and early twentieth centuries depart from the generalizations posited by Maurice Crosland and Jonathan Cawood in Forbes, *Human Implications* [note 1], pp. 114-25, 139-49.

4 USS, file on longitude differences. Oudemans to Colonial Minister, 28 Aug 1857.

5 USS, "Correspondentie Oudemans: Ministeries." Buys Ballot to Colonial Minister, 6 Oct 1857; Elliot, "Magnetic Survey of the Eastern Archipelago from Madras to Sumatra and Borneo," London, Royal Society, *Philosophical Transactions*, 1851, pp. 287-331.

desirable in Menado on northern Celebes and at Fort de Koek in north-central Sumatra. A twelve-station network would cost, he estimated, *f* 5300. The observations of all these stations were to be collected by the director at Batavia and sent to Utrecht.

The stations that Buys Ballot identified undoubtedly consisted of little more than small cabinets maintained by functionaries or physicians. Yet his letter is remarkable for the insight that it conveys about Dutch intents in the archipelago. It suggests a desire on the part of the Dutch authorities in the period around 1855 to extend their control beyond Java to the Outer Possessions, an expansionary program usually seen as emerging only a generation later. As we have seen in chapter two, Oudemans faced an analogous situation when he began his topographical duties. Exact sciences with little practical value—in this case, terrestrial magnetism—could indeed serve to consolidate control over peripheral territory.

Buys Ballot no doubt felt relief when Oudemans decided not to assume responsibility for the magnetical observatory, because the Utrecht meteorologist wanted the post for a protégé. The candidate, Pieter Adriaan Bergsma, had in fact been training for the position since May 1857, months before the colonial ministry approached Oudemans. Bergsma's career is indissociable from the history of the entrenchment of pure learning in the Dutch East Indies, and it is to this that we now turn.[6]

## *The Professional*

Bergsma's father was professor of botany at the University of Ghent. At the time of the geophysicist's birth, in 1830, Ghent belonged along with the rest of Belgium to the Dutch crown. With the secession of Belgium in 1831, the elder Bergsma moved to the University of Utrecht. There the son grew up and completed his education. In 1854 he received a doctorate from the faculty of mathematics and natural sciences for a dissertation on phosphorescence. Following a pattern usual among Dutch scientists, Bergsma obtained a teaching post in a *gymnasium* while completing his doctorate. At Utrecht, Bergsma fell under the spell of Buys Ballot, who infused him with the desire to carry out magnetical measurements in the East Indies. As a result the young physicist went to the royal academy at Delft, which since 1843 had been a government center for training future colonial civil servants.[7]

Bergsma began his course at Delft (which included the elements of Malay and Javanese) with the anticipation of receiving an Indian appointment, but his patron Buys Ballot had to lobby hard before the post came through. Early in 1858 Buys Ballot proposed to the colonial ministry that Bergsma supervise terrestrial magnetism for a salary of *f* 6000, which

6 The central document for Bergsma's life is the éloge written by Oudemans [note 1].

7 On the royal academy, Amry Vandenbosch, *The Dutch East Indies: Its Government, Problems, and Politics* (Berkeley, 1942), p. 158.

would increase annually by *f* 1200 to a maximum of *f* 9600.[8] The new minister in The Hague, Jacob Johannes Rochussen, preferred to see Franz Wilhelm Junghuhn head the operation, for the middle-aged German explorer and naturalist, who was well known to Humboldt, had made an impressive name for himself as an expert on the archipelago.[9] Buys Ballot insisted on his choice to Rochussen:

> I don't know anyone among the people who are in the Indies or would like to go to the Indies whom I could recommend besides Dr Bergsma, with respect to his experience in mathematics and physics as well as his persistence and zeal, of which he has given me proof since I last wrote you.[10]

Buys Ballot's eloquence triumphed. In the summer of 1858, Bergsma sat for his examinations at Delft and became a functionary, second-class, in the Indian service. He soon went off to study for four months in England and Ireland, then for three months in Germany—under Wilhelm Weber, the Schlagintweit brothers, and Johann von Lamont.[11] Bergsma had not yet received, however, an appointment in the *Indies*, and he negotiated with the colonial ministry to obtain the best possible conditions. He especially sought independence from his colleague and competitor Oudemans. He wanted to direct meteorology in the colony, and he also asked that "no civil servant would be placed over [him], but that [he] be directly under the director of public works." From the notes of the negotiations, it appears as if Bergsma never obtained the desired administrative independence. He signed on in August 1859 as a geographical engineer in charge of meteorology and terrestrial magnetism.[12]

Bergsma took nearly two years to assemble and calibrate his instruments, which finally cost *f* 13,000, and to complete his training at Utrecht and abroad.[13] He departed for Batavia in 1862 and set about finding lodgings and an observatory building. His cost estimates had proven far too low, and he faced stiff opposition from the Advisory Council of the Indies—the equivalent of an East Indian senate—regarding a request for *f* 30,000 in supplemental credits. It was a small amount, Bergsma argued to

8 USS, Oudemans's notes on cabinet documents. Buys Ballot to Colonial Ministry, 26 Jan 1858.

9 *Ibid.* Colonial Ministry to Governor General, 12 May 1858. On Junghuhn: M. J. Sirks, *Indisch Natuuronderzoek: Een beknopte geschiedenis van de beoefening der natuurwetenschappen in de Nederlandsche koloniën* (Amsterdam, 1915), pp. 141-53, and the secondary works cited there; Carel Willem Wormser, *Frans Junghuhn* (Deventer, 1944).

10 USS, Oudemans's notes on cabinet documents. Buys Ballot to Colonial Ministry, 26 Jul 1858.

11 *Ibid.* Undated note by Buys Ballot [1858]. On the Asian geophysical explorations of the Schlagintweits, *Encyclopaedia Britannica* (eleventh edition), *s. v.*

12 USS, Oudemans's notes on cabinet documents. Bergsma to Secretary General [colonial government], 12 Aug 1859; Bergsma's appointment, dated 2 Sep 1859.

13 *Ibid.* Various notes of Oudemans's, including quotations from a letter of Buys Ballot's to the Governor General, 23 Sep 1862.

the colonial ministry, when compared against British expenditures in meteorology—*f* 6 million over the preceding decade.[14] Bergsma received the money, but not a suitable site for his observatory. The advisory council remained hostile to the research program, but over their numerous objections Governor General Ludolf Anne Jan Wilt baron Sloet van de Beele provided Bergsma with land at Buitenzorg in the general vicinity of the botanical gardens.[15] A lustrum passed and still no buildings took shape. By 1870, some of Bergsma's carefully chosen instruments degenerated into hopeless disrepair and most had "not yet been used." For years Bergsma knocked high and low to obtain support for his work, but he remained a functionary without a proper function. One governor general replaced another at regular intervals, and colonial ministers passed in and out of office with indecent haste, while Bergsma's plans rebounded along seemingly endless passageways in the Indian mining office and the bureau of public works. All the while he operated from inadequate, rented quarters, taking nothing more than basic climatological readings.

Bergsma wrote to the colonial ministry in 1870 about his lack of progress. He could not leave Batavia to take measurements elsewhere in the archipelago, he argued, because he had no assistants with whom he could trust the delicate task of recording the earth's magnetic field. Bergsma desperately needed trained personnel to carry out his mandate. "One has a repeat here of what happens everywhere else, and that is that civil servants have been placed in charge of meteorological observations, when they have actually been trained to do quite different things."[16] The governor general in 1870 was Pieter Mijer, a man who had twice served in The Hague as colonial minister. In 1870 he urged his metropolitan ministry "to let Dr Bergsma keep his job for the sake of science and not withhold the means that he requires."[17]

Some men in the Indies looked askance at Bergsma's work and sought to discredit him in the eyes of the colonial regime. In 1869, a colonist published a critique of Bergsma's activity, asking whether any practical use would come from a magnetical and meteorological observatory at Batavia, whether the orientation of Bergsma's work toward pure learning should be continued, and whether the government should in any case fund the research. Bergsma penned a long and eloquent reply. He affirmed that his observations had led to no practical or useful results. One could not have expected otherwise: "Those observations will yield practical results at some point, when, after they have been continued for a period of time,. . . one will have discovered knowledge about the laws of the phenomena in the universe."[18] Merely to survey the climate of a new land would be a difficult

14 *Ibid.* Bergsma to Colonial Ministry [1862].

15 *Ibid.* Council of the Indies to Governor General, 12 Jun 1863; decrees of the Governor General, 1 Sep 1864.

16 *Ibid.* Bergsma to Colonial Ministry, 30 Jun 1870.

17 *Ibid.* Governor General to Colonial Ministry, 6 Jul 1870.

18 Oudemans, "Bergsma" [note 1], pp. 139-40.

task, and upon reliable data all future insight depended. Pure science had to remain unfettered by constraints of a practical nature, for one could never predict which part of science would furnish an application. Bergsma continued:

> Many are the applications that are a fruit of natural science, and when one verifies which investigations have yielded the most important of those applications, then one will see that they were mostly those observations carried out without the slightest thought of possible applications. One can never determine in advance if an observation will lead to any application. One can only assume that, in general, those observations which contribute most to the advancement of our knowledge will yield the greatest applications.[19]

In view of the considerable investment made by other countries for meteorological and magnetical research, Bergsma concluded, the Dutch nation could be proud to finance the research of the Batavia observatory.

Another critic sent a report to Governor General Johan Wilhelm van Lansberge. He urged the government not to authorize the meteorologist's new spending estimates.

> In general, the documents and reports do not give a favorable impression with regard to the actions of Bergsma. He has bought a large stock of instruments from England which have after ten years not even been used. The actual goal of the mission, the investigation of the magnetical phenomena on Java, has also been put aside. He criticizes the work of others; states that reports have been sent in by officers of the public health service when observations have not been carried out; and he anticipates using natives, who would have to be under the supervision of European personnel. I fear that one has already given in too much with regard to Bergsma's ideas. I suggest not to accede to the escalating demands of Bergsma, only allow him what is really necessary right now and try to get things back into proportion.[20]

Bergsma, his reputation and future livelihood at stake, defended his actions. He insisted that Java needed a first-class observatory. He emphasized that his scientific reports had to be printed locally, the standard practice at British colonial observatories. He could not use his instruments until he had a room for their proper installation. He directly confronted

19 *Ibid.*, extracts on pp. 142 and 145.

20 USS, Oudemans's notes on cabinet documents. Unknown to Governor General, 27 Oct 1870. As with other material from this file, the letter is extracted in Oudemans, "Bergsma" [note 1], p. 113. There Oudemans identifies the author as the new colonial minister in The Hague, Engelbertus de Waal.

the most serious charge, neglecting his duties in terrestrial magnetism:

> It is true that I have not begun magnetical registrations in the Dutch Indies, and this is an important part of the work assigned to me. The reason why I have not started is that, in order to carry out good observations, I first need an observatory where the changes in terrestrial magnetism can be observed continually. This is necessary to be able to correct observations made at different time intervals for diurnal, annual, secular, and irregular changes, and to reduce all these observations to the same [mean] time. If I had started this work before having a decent central observatory, then I would have had to do everything again later. . . . As long as I did not have an observatory equipped in such a way that it would be a central observatory to do magnetical measurements, and as there is still a chance that I will get a central observatory, I think that it would have been wrong if I had started with the measurements of the Indies. Besides, the state of the personnel of the observatory, as it is now, does not permit me to absent myself from the observatory for more than a couple of days.[21]

Bergsma referred to Buys Ballot's assessment, written in 1857, of the archipelago-wide network of observing stations, wherein non-commissioned officers made measurements. Buys Ballot had emphasized the essential nature of *scientific* supervision:

> Non-comissioned officers or natives are of no matter; it all lies in the inspection! . . . . It is impossible to carry out the duties of the director of a magnetical and meteorological observatory, to do magnetical and meteorological observations in the archipelago and visit regularly a large number of stations that are widely separated from each other, all at the same time.[22]

In the twentieth century we are familiar with the spectacle of scientists trying to persuade ignorant legislators or civil servants about the importance of their field of study. In the Netherlands during the nineteenth century, however, scientists did not as a matter of course advance their cause in the public arena, and in defending his *raison d'être*, Bergsma tread a path not frequented by many of his metropolitan colleagues. He continued to hammer for funds. In 1872 he tabled a new budget:

> 1) instruments that still have to be bought *f* 10,000; 2) personnel: 1 director *f* 450-*f* 1000 minimum-maximum, 1 assistant director *f* 4500-*f*800 minimum-maximum, 2 calculators *f* 200-*f* 350. Salary of minimum *f* 15,600-maximum *f* 30,000. Native personnel

21 USS. Oudemans's notes on cabinet documents. Bergsma to Colonial Ministry, 27 Jan 1871.
22 *Ibid.* Buys Ballot to Colonial Ministry, 6 Oct 1857.

> *f* 8040. Guarding and cleaning *f* 720. Gas lighting *f* 3294. Photographic paper *f* 1200. Small expenditures *f* 1000. Books, etc. *f* 750. Purchase of instruments, repairs, spare parts *f* 750.[23]

It would be a private empire, and his patron Buys Ballot argued in favor of cutting back the costs. The colonial ministry in The Hague, though prepared to make an initial outlay of *f* 159,300 and as much as *f* 47,260 annually, agreed with the Utrecht physicist.[24] By 1873 Bergsma agreed to abandon permanent magnetical stations in the Outer Possessions in favor of periodic visits by a magnetician, and to man his meteorological network with local, part-time observers.[25] He agreed to cut out one calculator and a number of natives. Bergsma insisted that the national interest required a first-class operation:

> National honor in the scientific area is at stake, and it would arouse the astonishment if not the indignation of the whole civilized world, if Holland, which in former years had such a prominent position where the advancement of knowledge and science was concerned, and in view of the many millions that its rich possessions overseas have yielded for the benefit of the Dutch treasury, could not spare even a couple of thousand guilders for the construction and maintenance of just one meteorological institution that only barely fulfilled the demands of science within the territory of its vast domain.[26]

Dutch scientists certainly kept close watch on what the rest of the civilized world was doing, and for this reason they no doubt felt that an appeal to national honor would strike sympathetic chords among administrators and politicians. How Bergsma finally obtained his observatory, however, has as much to do with educational and social *binnenlandse politiek* as with abstract arguments about knowledge and its accumulation. To understand this episode it is first necessary to consider in detail one of the foremost Dutch patricians of learning in the nineteenth century, Elie van Rijckevorsel.

## *The Gentleman*

Elie van Rijckevorsel was born into a wealthy and well-connected Rotterdam family in 1845. His grandfather Abram van Rijckevorsel, a successful trader, eventually went to the Dutch second chamber and became friends with major political figures like Jan Rudolf Thorbecke and Dirk Donker Curtius. His father, Huibert van Rijckevorsel, directed a large shipping company that, after initial success, faltered in 1858. In school Elie showed

23 *Ibid.* Budget for the observatory, 3 Feb 1872. The three-digit salary figures are no doubt monthly.

24 *Ibid.* Colonial Ministry to Governor General, 13 Mar 1873.

25 *Ibid.* Buys Ballot to Colonial Ministry, 28 Oct 1873.

26 *Ibid.* Bergsma to Council of the Indies (?), 27 Jun 1873.

special talent for languages. He did not get along well with his peers, and for this reason, when he was sixteen years old, his parents removed him from *gymnasium* in Rotterdam and placed him at a boarding school in Vianen.

In 1862 Huibert van Rijckevorsel went into a mental institution in Préfargier, near Neuchâtel, Switzerland. Elie and his mother followed along, while Huibert's brother-in-law Hendrik Muller handled the shipping firm. They lived in Zurich, where Elie attended the highest class of the secondary school attached to the polytechnic. The next year Elie returned to the Netherlands, leaving his parents in Switzerland. He wanted to study at the University of Utrecht in order to become a professor of the exact sciences. The career decision met with skepticism from Elie's grandfather, who favored something that would be socially useful. Abram's death in 1864 removed all barriers to Elie's chosen vocation. While at Utrecht, from 1863 to 1868, Elie was chaperoned by Hendrik Muller, who wrote long letters to Elie's mother about her son's progress. In the middle of Elie's university studies, in 1866, his father died in Switzerland.[27]

The Van Rijckevorsel family remained close to the men who directed affairs of state in the Netherlands. This special relationship appears in the circumstance of Uncle Hendrik's reporting, in one letter to Van Rijckevorsel's mother, about a discussion of her son's development with Isaac Dignus Fransen van de Putte, the Dutch statesman, where Van de Putte remarked on Elie's "aristocratic aspirations." In another letter Hendrik Muller elaborated on Elie's aristocratic pretensions.[28] The student of physics had access to princely resources, and this facility proved a source of unhappiness for him. In 1868 he became engaged to Cécile van Hogendorp, upon whom he showered gifts, including a horse and carriage. The young lady, alarmed at such treatment, broke off the engagement. Van Rijckevorsel's biographers are silent about what happened next, although it is clear that he drifted to Bonn to devote himself, more or less assiduously, to astronomy. During the Franco-Prussian War he operated an ambulance on the French side. He returned to Utrecht in 1871, rekindled with scientific ambition. He chose to work under Buys Ballot. His dissertation on the heat-conductivity coefficient in metals was crowned *magna cum laude* in 1872.

The twenty-six-year-old physicist, whose station freed him from the harsh realities of the work-a-day world, then conceived a desire to travel to the East Indies. He approached Buys Ballot about connecting his trip with a scientific research project. The two men settled on an extensive and

27 A long éloge of Elie van Rijckevorsel appears in J. E. van der Pot's *Abram, Huibert en Elie van Rijckevorsel* (Rotterdam, 1957) [*Roterodamum, 13*, ed. F. K. H. Kossmann of the Historisch Genootschap Roterodamum], pp. 92-118. An obituary by Ewoud van Everdingen appears in the *Nieuwe Rotterdamsche Courant*, 28 October 1928, reprinted in *HD, 26* (1928), 377-82. A recent reevaluation is provided in L. J. Pieters's "Dr Elie van Rijckevorsel, 1845-1928: Patriciër en meteoroloog," *Rotterdams Jaarboekje*, 1984, pp. 287-309. Biographical details are drawn from Van der Pot's and Pieters's studies.

28 The letters are cited by Van der Pot [note 27].

meticulous magnetical survey of the entire archipelago. Buys Ballot wrote to Bergsma, asking whether he might collaborate with Van Rijckevorsel in the undertaking. As we have seen, Bergsma, another former student of Buys Ballot's, had been appointed a decade previously to carry out, in part, just such a survey, but lack of funding to establish an adequate base of operations in Batavia, along with other claims on his time, had prevented him from visiting many far-removed Dutch possessions. Bergsma eventually realized that it would be best not to impede the plans of the new man. Van Rijckevorsel received the blessing of the colonial minister, Fransen van de Putte, as well as that of the governor general, James Loudon; both officials had been friends of his father's. To prepare himself for his task, he then went at his own expense to George Mathews Whipple's magnetical observatory at Kew and to Johann von Lamont's observatory in Munich. The colonial minister defrayed the cost of his instruments (most of which he purchased in England), and the navy lent him maps and chronometers. For the rest, he paid his own way. We shall return to examine the negotiations preceding his departure.

Between January 1874 and July 1877 Van Rijckevorsel carried out his measurements, "almost constantly travelling, but not always to the same effect."[29] During these years he suffered from malaria and eventually had to abbreviate his plans. By 1876 he had abandoned on-site caulations, deferring analysis until his repatriation. One of his Indonesian assistants died during the project, and a Dutch assistant died soon after it was concluded. He frequently appealed to the good services of the navy for making geographical or time determinations, as he had decided to take his measurements at sites previously established by Elliot of the Madras engineers or by J. A. C. Oudemans.[30] Bergsma, the geomagnetician sitting in Batavia, was not of much help to Van Rijckevorsel, as the Batavia observatory had not yet been completed. In the end, Van Rijckevorsel returned to the Netherlands, exhausted and with a great deal of data to reduce. The calculations, which took a number of years, benefitted from the "great ability and indefatigable diligence" of his friend, naval lieutenant Frederik Adrianus Jacobus Pascal van Alphen.[31]

With the results of his Indonesian survey in press, Van Rijckevorsel decided around 1879 to mount an analogous expedition to the eastern part of Brazil. Dutch authorities lent chronometers and made presents of the magnetical instruments that he had used in Indonesia. The Brazilian government, under instructions from the monarch Pedro II, provided him with a naval steamer for four months. All the railways owned by the

29 Elie van Rijckevorsel, *Verslag aan Zijne Excellentie den Minister van Koloniën, over eene magnetische opneming van den Indischen archipel in de jaren 1874-1879 gedaan* (3 parts, Amsterdam, 1879-1880), pt 1, p. 3. The report appeared as unnumbered parts of volumes 19 and 20 of the *Natuurkundige Verhandelingen* of the Royal Academy of Sciences in Amsterdam.

30 On Oudemans, see chapter two.

31 Van Rijckevorsel, *Verslag* [note 29], pt 3, conclusion. Pascal van Alphen identified in *NP*, *s. v.*

Brazilian government and many steamship companies gave him free passage. This considerable assistance served to certify the nature of Van Rijckevorsel's enterprise; he could have added the costs to those that he chose to assume—travel and maintenance for himself and an assistant, and salary for the latter.

The problems faced by Van Rijckevorsel in obtaining an assistant reveal that his project had the image of a marginal adventure undertaken by a gentleman. The professor of astronomy at Utrecht, the former colonial geographer Oudemans, received a letter in 1879 from the concerned father of a government engineer who was considering signing on for Van Rijckevorsel's expedition. The father had talked things over with Van de Sande Bakhuyzen, the professor of astronomy at Leiden, and as a result concluded that the expedition offered little for his son: "We were of the opinion that on such a trip his scientific knowledge would not increase, due to the one-sided, monotonous, and boring observations; also that he would become a less suitable or able engineer, due to the lack of practice in his field over so many years, the consequence of which he would suffer from afterwards." The father explained to Oudemans that his engineer son believed that having been on the expedition "would open doors for him later with respect to a career," but the older man balked: "I do not see this at all. I do not see any benefits." He asked Oudemans for his opinion in the matter.[32] The engineer son may have hoped to return from the expedition as a geophysicist Charles Darwin. His father knew that spending time *in partibus* without a government position would not guarantee a good job in the Netherlands.

Van Rijckevorsel arrived in Rio de Janeiro in December 1880, accompanied by 33-year-old Willem Rijklof Adriaan van Alphen, a civil engineer and aristocrat, as his first assistant.[33] There the two men promptly went to see the most accomplished astronomer at the Rio observatory, Emmanuel Liais, about their undertaking. Liais, a native of France, had risen to become *astronome titulaire* at the Paris observatory in 1856. After falling into disfavor with his superior, the misanthropic astronomer Urbain Jean Joseph Le Verrier, Liais left the premises. He went to Brazil, where Emperor Pedro II, an enthusiastic amateur scientist, placed him in charge of expeditions to observe a solar eclipse and to map the Brazilian coast. Liais found a place at the Rio observatory, rising at last to become its director for several years before stepping down.[34] When Van Rijckevorsel and Van Alphen met the expatriate Frenchman, he was into his downward slide.

32 USS. Steeport Pauwels to Oudemans, 14 Aug 1879.

33 Van Alphen identified in *NP*, *s. v.* He was distantly related to Pascal van Alphen.

34 Some discussion of Liais is provided in Abraão de Morais and Abraham Szulc's "A Astronomia no Brasil," in *As Ciências no Brasil, 1*, ed. Fernando de Azevedo (Rio de Janeiro, 1955), 80-161. His career is considered in greater detail in Lewis Pyenson, "Functionaries and Seekers in Latin America: Missionary Diffusion of the Exact Sciences, 1850-1930," *Quipu: Revista latinoamericana de historia de las ciencias y de la tecnología* (Mexico City), *2* (1985), 387-420, on pp. 393-6.

In a long letter to Oudemans, Van Alphen set down his impressions of meeting with Liais. Van Alphen recounted that Liais had placed a "roaring advertisement" about the Dutch expedition in a local newspaper, largely to promote the interests of his own institution. Liais did not come across well. "He made a definitely unfavorable impression on me," Van Alphen wrote. Liais was "in the black books of people" in the city and enjoyed his position to Pedro II, "who keeps him with one foot in the stirrups." Liais disapproved of Van Rijckevorsel's plans to determine longitude in Brazil only by use of chronometers, and he sought to persuade the foreign team to use the method of eclipsing Jovian satellites. Van Alphen resisted Liais's suggestion, offering that he and Van Rijckevorsel could not carry out such observations. Liais pressed the matter, only further alienating the Dutch observers. "He did not make a good impression on me at all," Van Alphen repeated, "not as a scientist and not as a human being either. He was too patronizing and on top of that too knowledgeable." Liais's observatory contained

> a wealth of instruments, which beyond some exceptions are all unused. It does not appear as if the instruments have ever been worked with. In one room there is a telescope on a scaffold, 10 meters long and 60 cm aperture, which has not been mounted; most of the instruments are like that. What a pity.

Liais asked Van Alphen if he wanted to be a member of a commission to observe the upcoming transit of the planet Venus in 1882. "Everything in this country is called a commission, even if it exists only by virtue of one person," Van Alphen commented. "I did not accept because we do not want to have much to do with him."[35]

In addition to describing his unpleasant meeting with Liais, Van Alphen indicated his plans for the future. He was the astronomer of the expedition, having spent a year studying under Oudemans at Utrecht,[36] and he began taking longitude measurements. He and Van Rijckevorsel would be making astronomical determinations of longitudes while on a Brazilian naval vessel, although when travelling to the interior they wanted to rely on chronometers, insofar as the timepieces could be transported safely. If transportation proved a problem, they would send for a telescope from the Netherlands to make absolute measurements. On other matters, Van Alphen reported on his concern over the prevalence of yellow fever in the Brazilian capital.

Van Rijckevorsel and Van Alphen set off in a Brazilian naval vessel that was too large to put in at many shore points. Some leagues east of the present state of Maranhão they were shipwrecked; the vessel went down, but they managed to save all their instruments and records. The two made

35 USS. Van Alphen to Oudemans, 2 Jan 1880.

36 Van Alphen mentions this fact in his letter, *ibid.*

their way to Pará to establish a northern headquarters. Within a month Van Alphen was dead—"One more added to the list of scientific martyrs killed by a tropical climate, and one, whose uncommon attainments justified high expectations of what he might have achieved."[37] Van Rijckevorsel wrote to Oudemans at the end of 1881 that he was "completely paralyzed" by the event:

> Probably you have already heard the sad news about the death of my colleague. First a fever. Like everyone who lives in the tropics the problems that he developed with his bile produced jaundice, which weakened him. After a month he died of cerebral anemia. The poor boy did not suffer, because from the moment that he was seriously ill he progressively lost his wits and lived in an atmosphere of pleasant dreams. But the sorrow of his family, especially of his wife-to-be, can scarcely be comprehended.

Van Rijckevorsel had now lost his astronomer, and he could not decide how to proceed with the measurements. He confided to Oudemans that he had neither the training nor the time to make absolute longitudinal determinations in the field. "I hope that you will not have too much contempt for me if I ask you for a simple recipe that I can just fill in, because I cannot study all these things seriously while I am travelling." He could not ask for local assistance:

> Probably it will astonish you that I am not asking the help of some naval officer. But the Brazilians are too ignorant and dumb apart from some exceptions. I have not found one who has ever seen the horizon. Futhermore, vanity and dishonesty happen to be two of the most lovely characteristics of the people here, and the person called upon would not hesitate to blaze abroad that he was actuallly doing my work, or at least that I don't know a damned thing about it.[38]

Van Rijckevorsel implored Oudemans to find an assistant who could calculate the latitudes, longitudes, and times upon his return to the Netherlands. He would "pay a salary equal to that of someone who starts at the HBS and would estimate the period of employment for two to three years." University professors struggled valiantly to obtain funding for assistants at this level; Van Rijckevorsel had the means to hire such an assistant without thinking twice about it.

Van Rijckevorsel persisted for another year and a half without the services of a trained assistant. He took down the longitudes as best he

37 Van Rijckevorsel, *Verslag* [note 29], p. 2. Van Alphen died in Pará on 7 Dec 1881. *NP, 12* (1921-22), 346.

38 USS. Van Rijckevorsel to Oudemans, 14 Dec 1881.

could, he reported in March 1882 to Oudemans, but he worried about their reliability:

> I am very willing to admit that the principal objection is the reluctance of someone who is not an astronomer, does not know the calculations, and does not know the small details that have to be calculated in the meantime, who does not know a single star, to start all the work.

A number of lines further on he wrote: "My main fear is the calculations." And again: "I have to confess to my disgrace that an astron. [calculation] looks like a dangerous mountain to me, one that I would like to travel around."[39] His problems only began with astronomy. Both he and his Dutch boy servant came down with his old nemesis, malaria. Transporting his chronometers inland became a source of great concern. Exhausted, he finally returned to Europe in May 1882. In his letter to Oudemans, he had projected only a few summer months in the Netherlands, and he did not think to spend more than "a few days" in Utrecht at the observatory. His health kept him home until June 1883.

He returned to Brazil with Lucas Christiaan Frederik Eduard Engelenburg, an assistant provided by his old patron Buys Ballot, who later rose to a high post at Buys Ballot's KNMI. The two rafted into the interior of the country, taking extraordinary precautions to protect their chronometers and magnetometers. As in the East Indies Van Rijckevorsel relied on the geographical determinations of his precedessors—notably the report of a United States naval expedition in 1878 and 1879, the results obtained by Liais in his survey of the coast, and the readings of French Admiral Ernest Barthélémy Mouchez.

After the second Brazilian voyage, Van Rijckevorsel undertook no further tropical expeditions. He carried out a magnetical survey of the Netherlands, as well as several other studies. He measured terrestrial magnetism in Switzerland with Willem van Bemmelen, just before the latter began his impressive tenure at the Batavia observatory. He travelled to scientific congresses in France, Germany, England, Canada, and the United States. For his efforts he garnered an honorary doctorate from the University of Glasgow—presented by William Thomson, Lord Kelvin. In 1904 he became an honorary assistant at the KNMI.

What seems most striking to us, in an age when the scientific enterprise places exhausting demands on the researcher far in advance of his taking the first lines of data, is the way that Elie van Rijckevorsel approached his research. Steadfast attention did not fail him, but his station always allowed him to see science as part of a broader cultural endeavor. When travelling he regularly set down his impressions—usually in the form of letters home but sometimes also as newspaper features.

39 USS. Van Rijckevorsel to Oudemans, 18 Mar 1883.

These drafts he later printed in limited runs and circulated to friends. After his Brazilian experience, he published a short book on the emperor. From Indonesia he assembled a large collection of native weapons and textiles, which he gave to a Rotterdam museum of which he was a benefactor. His sense of public service led him to serve in an ambulance corps during the Boer War, just as he had done thirty years previously during the Franco-Prussian War. He was a gifted illustrator, and on occasion he issued albums of his work.

At age sixty-four, Elie van Rijckevorsel married fifty-seven-year-old Jacoba Elisabeth Kolff. The two set up housekeeping in a small castle that Van Rijckevorsel had built several years previously at Doorn. He settled into the life of a maecenas—something that his extraordinary income (around the First World War he had available *f* 66,000 per year) allowed. Rotterdam institutions, especially, benefitted from his generosity. He died in the city of his birth at the age of eighty-three.

## Science, Politics, and the Patrician Impulse

The preliminaries are now in place for considering how metropolitan men of learning sought to insinuate themselves with colonial exploiters, and how a conflict developed between guardians of pure science and promotors of practical knowledge. The episode in question—the funding of the Royal Magnetical and Meteorological Observatory in Batavia—turns on the attitude of wealthy Dutch patricians toward government-funded scientific enterprises, and, inversely, the overtures of university professors toward private researchers.

In the early 1870s, it will be recalled, Pieter Adriaan Bergsma awaited construction of his observatory. He found himself caught between three masters: the colonial ministry (and its close relative, the navy) in The Hague, which originally authorized his appointment and funded his activity; the colonial government on Java (and its various departements, especially the naval departement) along with the local senate, the Council of the Indies; and Bergsma's old professor and patron at Utrecht, Buys Ballot. From the very beginning, Buys Ballot saw Bergsma's operation as a branch of his emerging empire in meteorology. As Buys Ballot wrote to the colonial minister in 1870:

> In 1857 the proposal was also made to send the observations done in Batavia to the meteorological institute and to have them printed here. The observatory in Batavia would then become a branch, in just the way that the observations at the English observatories in Toronto, the Cape, etc. were calculated and printed in England.[40]

40 RGA. Buys Ballot to Colonial Minister, 30 Sep 1870.

Although Buys Ballot supported the idea of carrying out calculations in the Indies and in this way gradually building up a colonial observatory, he implied that funding a new metropolitan observatory would in fact be the best means of processing knowledge originating overseas. Bergsma could think of little else than the observatory that had been promised him, he believed, upon his original appointment in 1859. In its absence, he declined to begin a magnetical survey of the Malay archipelago—his formal mandate—because he thought that the measurements would not be reliable.[41] Bergsma dunned the colonial ministry for his new buildings, an enterprise that Buys Ballot received with mixed feelings. Under these circumstances, it is hardly surprising that Bergsma found himself relegated for more than a decade to completely inadequate rented rooms.[42]

Elie van Rijckevorsel then appeared on the scene. With a newly minted doctorate in physics, he asked his adviser Buys Ballot if there were anything that he could do in the East Indies, whence he proposed to travel at his own expense. Buys Ballot immediately saw a way to bring about the magnetical survey that he had long desired. He realized that, with Van Rijckevorsel's connections in high places, the various ministries would even be willing to contribute to the scheme. He wrote to Bergsma, offering up Van Rijckevorsel as an unpaid assistant who, after checking in at Batavia, would head for the Outer Possessions in the archipelago. Bergsma was horrified at the thought that his project would be achieved without the need for a central observatory at Batavia; not only would his strategy for expansion be shown without substance, but he would also find himself open to the charge of professional incompetence! He refused to accept Van Rijckevorsel as a trainee and strenuously urged that another research project be chosen for the young patrician. Thereupon Bergsma and Van Rijckevorsel entered into a sharp correspondence about scientific and administrative territoriality.

The colonial ministry, though more than willing to oblige Van Rijckevorsel, refused to undercut Bergsma's authority. Sensing which way the wind was blowing, Buys Ballot trimmed his sails and lent his support to Bergsma's call for a first-class physical plant.[43] Construction of the Batavia observatory began during the next several years.[44] With funding for the

41 RGA. Bergsma outlined his position in a letter to Van Rijckevorsel of 29 Mar 1873.

42 Bergsma described his circumstances to Van Rijckevorsel in *ibid.*

43 RGA. Buys Ballot called for a first-class observatory at Batavia in a letter to the Colonial Ministry of 5 May 1873. This is to be compared with his support of a second-class institution in a letter to the Colonial Ministry of 30 Sep 1870.

44 According to Pieter Johannes Smits, the funds were authorized in 1873 and construction finally began in 1875. Smits, "Het Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia," *Het Nederlandsche Zeewezen*, 5 (1906), 161-4, 177-81, 193-8, on pp. 162-3. Until 1875, Bergsma was merely an engineer for the geographical service; with the beginning of construction on the observatory, he received the title of "director." In *Encyc.*, "Observatorium (Koninklijk-Magnetisch-Meteorologisch) te Batavia," *s. v.* Bergsma refered to the funding of construction for his observatory in a letter to Van Rijckevorsel of 14 Aug 1873 (RGA).

observatory at last guaranteed, Bergsma saw his way to dealing with Van Rijckevorsel in a collegial manner.[45]

*Metropolitan Interests and the Prosecution of Pure Learning*

When Buys Ballot sought to persuade the colonial ministry to fund an observatory in the East Indies, he emphasized the extent to which the project would contribute to national prestige. "It is to be regretted," he wrote to the colonial minister in 1870, "that Holland does not benefit from and does not care about [scientific activity in] these places, and that, therefore, it is inferior to England and, I regret to say, to what is being done by the Rajah of Travancore."[46] In another letter of 1870, Buys Ballot was even more explicit: "In all civilized countries, even in Spain, the publication of observations is more detailed than before, and what was sufficient ten years ago is no longer sufficient if we want to compete with other nations."[47] In Buys Ballot's eyes, national prestige related to the progress of science. In the 1850s, he supported a second-class observatory in the East Indies, but the heavy investment made by the British in meteorology at Kew and Greenwich directed the Netherlands to devote more effort to meteorology both at home and in the colonies.[48]

Though Buys Ballot commented at length and for the most part favorably on Bergsma's attempts to receive a new observatory, the man in Utrecht hesitated to set up a rival institution. He leaned toward having the colonial observations analyzed and printed under his control in the Netherlands. He allowed, however, that Bergsma could gradually take charge of these functions as his material surroundings improved through acquisition of a library and assistants.[49] He indicated to the colonial minister that one way to save money would be to have Bergsma make use of civil servants or naval officers for processing the calculations; the government had a splendid occasion to economize by engaging the "experienced and accurate scientist Dr E. van Rijckevorsel," travelling to the East Indies under his own steam.[50]

45 RGA. In October 1873, Buys Ballot approved plans for the new Batavia observatory. Secretary General in the Colonial Ministry to Buys Ballot, 27 Oct 1873.

46 RGA. Buys Ballot to Colonial Minister, 28 Feb 1870. Rama Vurmah, the Rajah of Travancore, founded an observatory at Trevandrum in 1836. The first director, John Caldecott, installed a Dolland equatorial telescope (focal length 7 feet, aperture 5 inches), and forwarded many observations to the Royal Society of London, although none was published. J. A. Broun, *Report on the Observatories of His Highness the Rajah of Travancore at Trevandrum, and on the Agustier Peak of the Western Ghats* (Trevandrum, 1857), pp. 1-9. From 1852 to 1869 John Allan Broun took magnetical and meteorological measurements. Broun, *Observations of Magnetic Declination made at Trevandrum and Agustia Malley. . . in the Years 1852 to 1869* (London, 1874). See Derek Howse, "The Greenwich List of Observatories: A World List of Astronomical Observatories, Instruments and Clocks, 1670-1850," *Journal for the History of Astronomy*, *17*, pt 4 (1986), i-iv, 1-100, on p. 35.

47 RGA. Buys Ballot to Colonial Minister, 30 Sep 1870.

48 *Ibid.*

49 *Ibid.*

50 RGA. Buys Ballot to Colonial Minister, 5 May 1873.

In arranging for the extension of his empire in meteorology, Buys Ballot had to walk a narrow line between the claims of pure knowledge and the useful ends that his knowledge might bring. "The main purpose [of the proposed Batavia observatory] was and still is to carry out magnetical observations of the East Indian archipelago," he wrote to the colonial minister in 1870. He added that shipping companies looked forward to completion of the project "as it would improve the efficiency of navigation." He repeated later in the letter that the central observatory at Batavia and the regular recording of magnetical elements in the archipelago were of "much importance for science and for practical ends."[51] Buys Ballot did not want to install Bergsma in a rival institution, however, and he consistently underplayed the *meteorological* tasks of the proposed observatory. Buys Ballot remained the ultimate Dutch weatherman. His problem concerned Bergsma, whom he did not control and who understood the political and practical value of producing meteorological reports in the East Indies. Buys Ballot received a pointed query on this conflict from the colonial minister:

> While you always attached much importance to the magnetical observations and while you accorded less weight to meteorological observations, as mentioned in your letter of 28 February 1870, N° 210, for Dr Bergsma the constant meteorological observations are a major issue, and it is due to this that his proposals are accompanied by a demand for such exhorbitant sums.[52]

Buys Ballot bowed to the pressure, henceforth speaking of "magnetical and meteorological observations" in one breath.[53]

Into this complicated rivalry stepped Elie van Rijckevorsel. He earnestly desired to visit the East Indies "in order to acquaint myself with the country which means so much to us and which is so important to us." Upon his graduation, as he related to Bergsma, "this idea started to take shape, and I wondered whether I could not serve science during my journey."[54] When Bergsma learned about Van Rijckevorsel's project to carry out a magnetical survey of the archipelago, he became jealous and fearful—jealous that a younger man would achieve what he sought to accomplish, fearful lest his position be considered superfluous. Bergsma sought to persuade Van Rijckevorsel to undertake a more modest project, one that in any case would garner the observer few laudatory comments in European circles. He suggested two of these: measuring the heights of Javan mountains, and determining the temperatures of East Indian springs.[55]

51 RGA. Buys Ballot to Colonial Minister, 30 Sep 1870.
52 RGA. Colonial Minister to Buys Ballot, 14 Feb 1873.
53 RGA. Buys Ballot to Colonial Minister, 5 May 1873.
54 RGA. Van Rijckevorsel to Bergsma, 10 May 1873.
55 RGA. Bergsma to Van Rijckevorsel, n.d.

These pedestrian projects, of practical appeal, were suitable for an independently wealthy transient. Science had to be reserved for the professionals.

*Government Professionals and Private Patrons*

The colonial ministry saw the potential for conflict in Van Rijckevorsel's expedition. The minister, Fransen van de Putte, emphasized to Buys Ballot: "As Dr van Rijckevorsel will carry out his observations under Dr Bergsma, it is extremely important that the relations between these two gentlemen are defined to avoid unpleasant confrontations."[56] Buys Ballot explained to Van Rijckevorsel about Bergsma:

> All the trouble that he has gone through now finally may yield fruit, and. . . therefore he will not be very amused if another person reaps the benefits or, rather, executes the main plan, because that is what it amounts to—that you will reap the actual harvest of the seed that he sowed.[57]

He painted a different picture for the colonial minister:

> It appears to me as if they, as scientists who envisage one and the same purpose, would automatically support each other. If this is not the case, one could work independently of the other, and then I would like his Excellency to consider giving the trip of E. van Rijckevorsel no official character. . . .[58]

The minister, however, insisted that his long-time functionary not be undercut by a private adventurer:

> I should like to specify that the observations will be done under the *supervision* of Dr *Bergsma*. . . . The goal of Mr van Rijckevorsel would be easier to attain if he consulted with Mr Bergsma about the execution of his plans and profited from the latter's experience accumulated in the Indies. Therefore, I believe that here *cooperation* is the key word.[59]

At the same time, the minister used Buys Ballot's rhetoric about the nobility of the scientific enterprise to respond to Bergsma's complaints about having his mandate eroded. Granting official recognition to Van Rijckevorsel's expedition, Minister Van de Putte emphasized, would not threaten Bergsma's position. This official support "would only be the just

56 RGA. Colonial Minister to Buys Ballot, 10 Jun 1873.
57 RGA. Buys Ballot to Van Rijckevorsel, 17 Aug 1873.
58 RGA. Buys Ballot to Colonial Minister, 21 Jun 1873.
59 RGA. Colonial Minister to Buys Ballot, 6 Sep 1873.

acknowledgment of Dr van Rijckevorsel's work, which I believe is only justified, as he lends us his knowledge and time for the benefit of the country without any financial compensation."[60] Van de Putte did not mention that it was also a way for the colonial ministry to finance pure learning—technically the charge of his colleague at the head of the interior ministry.

Bergsma first learned about Van Rijckevorsel's plans in March 1873. Buys Ballot relayed his support of the impending expedition, which had taken shape due to Van Rijckevorsel's "connections through his father with the colonial minister and the governor general."[61] Bergsma offered that while he would appreciate the company, he could not extend accommodations. He asked Van Rijckevorsel for a copy of his dissertation and for information regarding "which field you have specialized in and which part of science attracts you most." He also asked Van Rijckevorsel to put in a good word with the colonial ministry about his future observatory.[62] Van Rijckevorsel then explained his plans to Bergsma, placing responsibility for the choice of the magnetical survey on Buys Ballot's shoulders. Van Rijckevorsel wanted to remain "independent," but he hoped for a "pro-forma" appointment. He asked for Bergsma's blessing in his search.[63]

Van Rijckevorsel's innocent request drew a hostile response. Bergsma wrote:

> I cannot possibly oblige you, if my opinion were to be asked by government representatives. . . I would then voice the opinion that your request was an infringement on my rights. These observations were confided to me in 1859 by royal decree. It is true that I have until now not been able to execute my orders because I have not been supplied with the means to do so according to the present demands of science; but this does not give the government the right to give these orders to someone else, unless neglect of duty from my side was the reason for my not beginning. . . .

The magnetical survey did not rank high on a list of projects with practical consequences, and preliminary information of the kind that Van Rijckevorsel proposed to collect would be used by the government to argue against financing a more detailed investigation:

> It seems to me that you, as an honest scientist, should not try to make efforts to this end as long as it has not been proved that I have not carried out my duties here and that it would be

60 RGA. Colonial Ministry to Buys Ballot, 27 Oct 1873.

61 RGA. Buys Ballot to Bergsma, 4 Feb 1873, cited by Bergsma in a letter to Van Rijckevorsel, 29 Mar 1873.

62 *Ibid.*

63 RGA. Van Rijckevorsel to Bergsma, 10 May 1873, draft.

> necessary for the government to replace me. If you want to carry out magnetical observations privately, then I do not object, and if I can be of any help to you I will come forward gladly. You should not forget, however, that science is hurt by half-work more than it profits by it. There is not much to be made out of deficient work, and it has the drawback that good work is then obscured, for the government would certainly be led to believe that enough work has been done.[64]

Bergsma concluded: "The field of science is too varied, it seems to me, for you to work in exactly the same area as I." These strictures did not disturb Van Rijckevorsel. Science, he emphasized to Bergsma, was dispassionate and without favorites: "The ordinary courtesy between scientists, I believe, has never caused a plan to be discarded because another person had designs for the future, designs which have not even been implemented."[65]

Bergsma assembled the support necessary to block Van Rijckevorsel's proposal. He had the naval commander of the East Indies and the governor general write letters of protest to the colonial ministry in The Hague. As he explained to Van Rijckevorsel:

> If the founding of an observatory were not involved, then my judgment of your intentions would have differed completely. Perhaps nothing will come about regarding the observatory, and then the matter is of no interest to me; that I cannot say with certainty yet. Only I fear that your actions will influence the founding of the observatory unfavorably, that the minister will think that because you are going to the Indies to carry out magnetical observations, these will be sufficient for now and the observatory can remain as it is for an indefinite period of time.[66]

The issue of scientific territoriality could not be expressed more clearly.

In the eyes of the Dutch authorities, the prosecution of pure learning was a task remanded to civil servants, and private efforts had to cede to public authority. As we have seen, the government was uncomfortable with the thought that private initiative would intrude on the mandate of a government man of learning. Without compromising its integrity in the matter, it met the issue half way: It agreed to support the private expedition while at the same time financing a permanent authority in the same area of study. The conclusion was a *modus vivendi* between the patrician Van Rijckevorsel and the government physicist Bergsma: Van Rijckevorsel carried out an important investigation, and Bergsma received the world's finest colonial geophysical observatory. Practicality and peaceful coexistence within recognized spheres of influence—the principles of Dutch

64 *Ibid.*

65 RGA. Van Rijckevorsel to Bergsma, undated but probably 14 Aug 1873.

66 RGA. Bergsma to Van Rijckevorsel, late 1873.

foreign policy during the last half of the nineteenth century—found an application in the area of science policy.

The funding of the Batavia observatory is exemplary of a more general tendency among educational administrators and their political chiefs in the Netherlands during the nineteenth and twentieth centuries. The government consistently resisted becoming involved in institutions for the prosecution of pure science, preferring to see interest manifest by wealthy individuals before adding an enterprise to its budget estimates. This is precisely the pattern revealed in the preceding chapter with regard to the creation of overseas astronomical observatories. The pattern will be met again in chapter four when discussion turns to the rise of universities in the Indies.

The *concordat* regarding Van Rijckevorsel's expedition and Bergsma's observatory spanned class barriers. Van Rijckevorsel, born into an old family of traders, belonged to the Dutch bourgeoisie, resplendent and assertive in the wake of commercial successes related to a new agricultural regime in the East Indies and, as well, to the rise of industry on the Rhine and its tributaries. Buys Ballot, seeking to expand his academical empire, also represented the prerogatives of traditional wealth and ease, although in a way different from Van Rijckevorsel. Bergsma, university-certified but (until his observatory materialized) at an *engineering* post in the colonies, was one of the earliest *professional* scientists in the Netherlands: He had a mandate to publish new scientific results. In deciding how to proceed, the colonial minister had to take account of the special interests of each man.

The resolution of the impasse served to affirm the sanctity and the accessibility of the scientific *beroep*, or calling. Science was an enterprise much as Buys Ballot portrayed it: noble, dispassionate, and open to men of all stations in life. Scientific activity had a practical side. Scientists, by their very nature, turned the wheels of commerce.

## The Transition to Questions of General Importance

With his central observatory secured, Bergsma began to implement the Humboldtian program that he took to be his mandate. The program required European-trained fact-collectors. To his staff of Indonesians he added, in 1874, the services of a naval lieutenant, L. Backer Overbeek. He circulated a call for a "doctor in mathematics and physics" to become assistant at the observatory which, in 1875, had still to be constructed.[67] The man he received as second-in-command, in 1877, was Johannes Paulus van der Stok, a young *gymnasium* professor who had recently completed a doctorate at Utrecht on electrical energy.[68] For five years the two Dutch scientists labored to assemble time series for meteorology and tides.

67 Smits, "Koninklijk" [note 44], for appointments. For the announcement of the post: USS, Oudemans's notes on cabinet documents. Bergsma to Colonial Ministry, 12 May 1875.

68 "Johannes Paulus van der Stok," *Amst. Versl.*, *37* (1934), 266-9.

9. Royal Magnetical and Meteorological Observatory, Batavia, director's residence, 1911. Institut für Geophysik, Göttingen.

Magnetical recordings—the most difficult and time-consuming of nineteenth-century meteorological tasks—receded into the background; Van Rijckevorsel's excursions to the Outer Possessions found no immediate successors emanating from Batavia.

It would be well not to judge the nineteenth-century fact-collectors too harshly. The Humboldtian program in geophysics extended the research ethic to telluric and climatological phenomena. Its inspiration came from philology, and the model can be found in the *Monumenta Germaniae historica*: the annotation and diffusion of critical texts—the facts upon which synthetic history was to be written. Just as philologists were held to require critical editions, so astronomers required reliable star charts, chemists required handbooks of organic compounds, mathematicians required tables of analytical functions, botanists required herbaria, and weathermen needed isostatic charts. One may question whether the fruit of these labors justified their cultivation, but there can be no doubt that the enterprises entailed significant epiphenomenal gains. They attracted long-term funding commitments from educational ministries, and they functioned, more often than not, as a nursery for young scientists who would later carry out major syntheses. Much of science today basks in the glow of the great, if ultimately sterile, Humboldtian projects.[69]

The Humboldtian research ethic suffused the activity of the Batavia

69 Historical prosopographies, the annual North-American Christmas-day bird census, and billion-dollar particle accelerators all have roots in the exhortations of Alexander von Humboldt.

observatory until the end of the nineteenth century, but not so to the exclusion of placing the institution on a firm organizational footing. Accumulation of data conformed to the perceived needs of the observatory. Data series were established at Batavia, and preliminary climatological surveys were taken for the archipelago, but relatively less attention went to recording seismology and terrestrial magnetism, which required meticulous observations on delicate instruments. Bergsma had obtained his central observatory, and his principal interest lay in providing for it.

Bergsma's health gave out in 1882, and he set off for the Netherlands on sick leave. He died on board a mail steamer in the Red Sea. Van der Stok, left alone, sorted through a mountain of rapidly accumulating meteorological data. He lasted for six months before moving to a Javan hill station to regain his strength. The naval departement appointed Lieutenant J. J. Poortman as acting director. Van der Stok would not have it, especially since 1882-83 had been designated as a year for international magnetical observations. Against the advice of his physician he returned to supervise the observatory. Once more he succumbed to illness, and within the year shipped out to recover in the Netherlands. As a consequence, the rudderless observatory took no significant observations during the eruption of Krakatoa in August 1883. Poortman handed over administration in 1884 to a new adjunct director, Simeon Figee, who in 1877 had received a doctorate in physics from Leiden.[70] Van der Stok returned to take charge in 1885. From his office as director, he participated in the popularization of science at the Koninklijke Natuurkundige Vereeniging.[71] He remained director until 1899, when he moved to head the marine-observations section of the KNMI in the institute's new quarters at De Bilt's Koelenberg manor. Figee then rose to steer the Batavia observatory, which in 1898 had received a royal prefix, into the twentieth century. His hand on the tiller was firm, and his course was clear. Figee's assistant director, Willem van Bemmelen, became the ranking officer at the observatory in 1905, upon Figee's return to the Netherlands on medical furlough.[72]

Though their interests were principally meteorological and tidological, Van der Stok and Figee began, in the 1880s, to devote more serious attention to terrestrial magnetism and atmospheric electricity. They concentrated on instrumentation, eschewing links with theory, or, as Van der Stok put it in 1885, "with exclusion of all attempts at explanation and speculation."[73] These initiatives would by themselves have led to respectable publications, but the critical appearance of Van Bemmelen propelled the observatory to the front ranks of geophysics.

70 Figee, *De Akustische Methode ter bepaling van den coefficient van veerkracht toegepast op eenige tropische houtsoorten* (diss., Univ. Leiden. 1877), no adviser indicated.

71 Van der Stok authored two of the KNV's *Voordrachten*: *Proeven met zeepbellen* (Batavia, 1890) [N° 5]; *Dubbelsterren* (Batavia, 1892) [N° 9].

72 Smits, "Koninklijk" [note 44], pp. 163-4.

73 Van der Stok, in "Observatorium, Batavia," *Encyc.*, *s. v.*

10. Royal Magnetical and Meteorological Observatory, Batavia, courtyard, 1911. Institut für Geophysik, Göttingen.

Willem van Bemmelen was the son of Jacob Maarten van Bemmelen, a highly-regarded professor of inorganic chemistry at Leiden who had himself passed through the Indies. He attended the local HBS and followed its modernist reform curriculum, although he succeeded in the leaving examinations at a Rotterdam *gymnasium*. Then he went to his father's university. He became interested in the historical evolution of the earth's magnetic field, receiving a doctorate in 1893 for a thesis on terrestrial magnetism in the sixteenth and seventeenth centuries. It was a historical study, based on maritime logs for 38 voyages of the East India Company which recorded about one thousand declination measurements and many compass deviations. This he followed with a study of the secular changes in the geomagnetic field since 1500. In 1896 and 1897 he teamed up with the foremost Dutch magnetical surveyor, Elie van Rijckevorsel, scaling the Swiss Alps to determine the variation of the earth's magnetic field with altitude.[74] Van Bemmelen carried out his early work as an assistant in charge of terrestrial magnetism at the KNMI in Utrecht. Van Bemmelen's brother Johann Frans

74 On Willem van Bemmelen: Cornelis Braak, "In Memoriam Dr W. van Bemmelen," *HD*, *39* (1941), 78-81; *Persoonlijkheden in het Koninkrijk der Nederlanden in woord en beeld: Nederlanders en hun werk*, ed. H. Brugmans (Amsterdam, 1938), pp. 106-7; *NP*, *59* (1973), 21; J. Veldkamp, *History of Geophysical Research in The Netherlands and its former Overseas Territories* (Amsterdam, 1984), p. 13. On Jacob Maarten van Bemmelen: H. A. Lorentz, "J. H. van't Hoff en J. M. van Bemmelen," *Chemisch Weekblad*, *8* (1911), 279-86; H. A. Lorentz, "In Memoriam J. M. van Bemmelen," *Chemisch Weekblad*, *8* (1911), 261-5; F. A. H. Schreinemakers, "Iets over het wetenschappelijk werk van Prof. Dr J. M. van Bemmelen," *Amst. Versl.*, *21* (1913), 1401-12.

had worked as a biologist in the Indies from 1891 to 1895; the experience launched him into a successful university career at home.[75] In 1898, when the KNMI moved to De Bilt, the thirty-year-old geophysicist shipped out for Batavia to replace Figee as adjunct director.

He arrived at an opportune time because the object of his expertise, terrestrial magnetism, had become impossible to monitor at the Batavia observatory due to a new electrical streetcar line. The entire magnetical operation, as a result, went to the botanical gardens at Buitenzorg. It was largely an automated system, although here, as elsewhere in modern life, automation required regular solicitation by human hands. In this case, an Indonesian observer supervised the Buitenzorg instruments, which by 1910 consisted of two magnetographs.[76] Freed from the druggery of making routine measurements, Van Bemmelen turned the resources of the observatory to his advantage, especially since the director, Figee, gave free rein to the scientific ambitions of his understudy. Beginning in 1903 Van Bemmelen repeated Van Rijckevorsel's magnetical survey of the archipelago—an exercise that his predecessors could only dream about.[77]

Routine fact collecting, however, held few attractions for Van Bemmelen. His arrival coincided with the observatory's acquisition of a Milne seismograph and its decision to record, regularly and reliably, local earthquakes. Batavia hosted the first Dutch-operated seismological operation, beginning six years before a similar service came to the KNMI.[78] In 1907 Van Bemmelen extended the coverage of Batavia's observations by installing self-registering seismographs at Ambon and Padang.[79] By this time his marriage to Soetje Hermance de Jongh, at Batavia in 1899, had produced three children.[80] After holding Figee's place for three years and having a pensioned naval officer as a second-in-command, in 1908, at age forty, Van Bemmelen received a permanent appointment as director. He promptly departed for an extended stay in Europe and temporarily left the observatory in the hands of Cornelis Braak, a former student of Kamerlingh Onnes's. Van Bemmelen returned to his post in 1910, refreshed and eager to exploit his institution.[81]

As his first task, Van Bemmelen inaugurated an annual report of the observatory's activities. At the beginning of the first report, published in 1911, he emphasized that he had mandates in both pure science and

75 On the East Indies connection for Van Bemmelen's father and brother, *Eeuw*, p. 17.

76 Smits, "Koninklijk" [note 44], p. 178. In 1910, the first year for which the observatory issued a report, R. Soedjono was the Buitenzorg observer, and his magnetographs were a Schulze & Töpfer and an Adie. *Bat. Jaarversl. 1910* (1911), pp. 12-14.

77 Van Bemmelen, *Magnetic Survey of the Dutch East Indies Made in the Years 1903-1907*, appendix 1 to Batavia, Royal Magnetical and Meteorological Observatory, *Observations*, *30* (1907) [Batavia, 1909].

78 Veldkamp, *History* [note 74], p. 69.

79 "Observatorium," *Encyc.*, *s. v.*

80 *Persoonlijkheden* [note 74]; *NP*, *59* (1973), 21, indicates a son who died young.

81 "Observatorium," *Encyc.*, *s. v.* for the brevet promotion from 1905 to 1908. Braak, *Isothermen van waterstof* (diss., Univ. Leiden, 1908).

practical learning. This manifesto served to justify the observatory's prosecution of seismology and upper-atmosphere physics as well as rainfall and magnetical measurements; it made publication of original findings in international journals a legitimate part of the staff's activity, the same as if the physicists had held appointments in an academic setting.[82]

The observatory divided into sections organized around research programs and data registration. The largest practical task concerned monitoring and reporting rainfall around the archipelago, and more than half the staff seem to have worked on nothing else. Other sections dealt with magnetical recordings at the Buitenzorg station; seismological observations at Batavia and, for a time, at Ambon and Padang; the daily time service; and solar observations. The staff, in 1910, comprised Van Bemmelen as director, Braak as adjunct director, and two Dutch calculators, Pieter Johannes Smits and F. Rijken Rapp; farther down on the payroll came twelve native assistants, in four classes, and two native apprentice-assistants.[83] From the time of his investiture, Van Bemmelen juggled the books to obtain additional posts at the top. He funded a temporary position for a retired naval lieutenant, Frederik Hendrik Staverman. To advance his favored line of research—upper-atmosphere physics—Van Bemmelen obtained the services of another naval lieutenant, Alfred Emile Rambaldo, along with a European calculator and a European clerk.

Research into the upper atmosphere related directly to the problems of air transportation. Lt Rambaldo, a pioneering Dutch aviator, had already begun to look into tropical weather in 1908, when he and the German physicist Kurt Wegener discussed the possibility of surveying New Guinea from the air. Beginning in 1909, when he served on the armored warship "De Ruyter," he made fourteen balloon ascents in the Indies. The navy provided extensive support for this kind of research until, with the death of Rambaldo in 1911, it realized that nothing much would be delivered in the way of predicting the weather.[84] The Netherlands Indies Association for Aviation donated a large free balloon. Van Bemmelen created a monograph series for publishing the results of his aerological research. The first four numbers of the observatory's *Verhandelingen* and another number in 1920 went to balloon observations.[85] In the late 1920s,

82 *Bat. Jaarversl. 1910* (1911), manifesto on p. 4.

83 BAN, Bt 1 Mar 1911, N° 30, for Smits's vita.

84 For Rambaldo: L. Honselaar, *Vleugels van de vloot: De geschiedenis van de marine-luchtvaartdienst* (Rotterdam, 1950), pp. 13-22; J. E. van Zwieten, "Op Speurtocht in oude archieven," in *Een Halve Eeuw militaire luchtvaart*, ed. R. W. C. G. A. Wittert van Hoogland (The Hague, 1963), pp. 35-62, pp. 41 and 44. A full-length portrait may be found in S. P. L'Honoré Naber, *A. E. Rambaldo, Luitenant ter zee der tweede klasse; Baanbreker voor de luchtvaart in Nederland, in West- en- Oost-Indië, 1879-1911* (The Hague, [1932]), pp. 39-73 on Rambaldo's activity in the East Indies and especially at the Batavia observatory. Rambaldo, son of the resident of Rembang, died when he fell from a balloon flying from Soerabaja to Semarang.

85 Van Bemmelen, *Die Wind-Verhältnisse in den oberen Luftschichten nach Ballonvisierungen in Batavia* (Jakarta, 1911) [*Bat. Verh.*, N° 1]; Cornelis Braak, *I. Drachen- und Fesselballon-Beobachtungen; II. Wissenschaftliche Ergebnisse der Aufstiege mit dem Freiballone "Batavia"* (Jakarta, 1912) [*Bat. Verh.*, N° 2];

11. Royal Magnetical and Meteorological Observatory, Batavia. Indonesian staff receiving service medals, between the world wars. Badan Meteorologi dan Geofisika, Jakarta.

Van Bemmelen's protégé Jan Boerema continued upper-atmosphere research with a view to determining the most economical routes for commercial aviation.[86]

Professional strategies in science draw on the full range of individual temperament, and colonial scientific institutions exhibit the same variation as their metropolitan homologues in this regard. The strategies are constrained, however, between the two poles of administrative skill and research acumen. A talented administrator who supervises the expansion of his staff can, in science no less than in commerce or government, expect

Braak, *Drachen-, Freiballon- und Fesselballon-Beobachtungen* (Jakarta, 1915) [*Bat. Verh.*, N° 3]; Van Bemmelen, *Results of Registering-balloon Ascents at Batavia* (Jakarta, 1916) [*Bat. Verh.*, N° 4]; Van Bemmelen, *Results of Pilot-Balloon Observations at and near Batavia in the Years 1911-1918* (Batavia, 1920) [*Bat. Verh.*, N° 6]. Braak, "Meteorologie en klimatologie: I. Tot 1296 [*sic*]," in *Eeuw*, pp. 71-5, on p. 74. Van Bemmelen situated his work in historical perspective in "De Luchtoceaan gepeild," *1° NINC Hand.* (1920), pp. 14-23

86 J. Boerema, "Meteorologie en klimatologie: II. Van 1926 tot aan de oorlog in de Pacific," in *Eeuw*, pp. 75-7.

to be catapulted into responsibilities of increasing scale, complexity, and prestige. A prolific and innovative researcher who attracts the attention of distinguished colleagues in distant locations can anticipate, circumstances and resources permitting, a call to sit at one or another High Table. Special features of the Dutch system of higher learning encouraged colonial scientists to apply themselves to both administration and research. In the first place, Indian service promised retirement in the Netherlands with a substantial pension and the time to enjoy it. Returning to the metropolis early in the twentieth century, one could look forward to a nominal research affiliation with a Dutch institution and not have to worry about a salary. In the second place, time spent at a governmental scientific institution in the colony would generally be credited toward advancement within metropolitan homologues. Van Bemmelen saw his predecessors Oudemans and Van der Stok rise, by virtue of their research and administration, to occupy important positions in the Netherlands.

Around 1911 Van Bemmelen, in concert with his metropolitan colleague Van der Stok, began to lobby for the creation of upper-level scientific posts. In 1911 he succeeded in installing Staverman as the first *wetenschappelijk medewerker*, just below the adjunct director in the observatory hierarchy; Staverman continued to devote all his attention to rainfall. The compromise here is evident: The colonial navy authorized a research position, but the first incumbent labored at a practical task.[87] Staverman occupied the post for one year and then went to Europe on leave. His replacement was 29-year-old Jan Boerema, who had just completed a doctorate under Hermann Haga at Groningen.[88] In 1914 came an inflationary reorganization that befitted a research institute. The first calculator Smits, who had been functioning as a researcher, was reclassified as *hoofdobservator*, or main observer; the other calculators were renamed observers; the clerks were promoted to calculators; and at the bottom came a score of Indonesian assistants.[89] As the number of observers, calculators, and assistants grew, their ranks differentiated into various classes depending on eduational background and experience; those with a diploma from a HBS, for example, received higher salaries.[90] Van Bemmelen's reorganization set the pattern of administration for the next generation. New positions materialized when technology demanded and funds permitted. Posts for an instrument-maker and a radio-telegraphist (for the time service) made an appearance during the 1920s between observers and adjunct observers. In the middle 1920s, a few clerk-calculators came on the rolls between the observers and the assistants. When funding for science dried

87 *Bat. Jaarversl. 1912* (1913), Staverman on the rainfall detail in the list of personnel, p. 4 for the intervention of Van der Stok.

88 *Bat. Jaarversl. 1913* (1914), p. 5. Boerema, *De Electromotorische Kracht van het Weston-normaalelement* (diss., Univ. Groningen, 1913).

89 *Bat. Jaarversl. 1914* (1915). Smits's capabilities are revealed in his sophisticated monograph, *Harmonische Analyse der watergetijden* (Batavia, 1910).

90 *Bat. Jaarversl. 1918* (1919).

up in the early 1930s, salaries and positions shrank, but until then the observatory employed four and sometimes five senior people.

Women were prominent at the Batavia observatory, although only one seems to have reached, by virtue of her university studies in the Netherlands, a senior post. In 1919, for example, all eight calculators were unmarried women, as were two of the four observers.[91] By treating women this way, the observatory directors simply copied European and North-American practice; in the metropolis women had for decades been scanning the heavens and processing the data of astronomers and meteorologists. If a woman with a doctorate had knocked and persisted in knocking on the observatory's door, it is likely that she would have been named scientist; this would have provoked less consternation than if a similarly certified native Indonesian had presented himself.

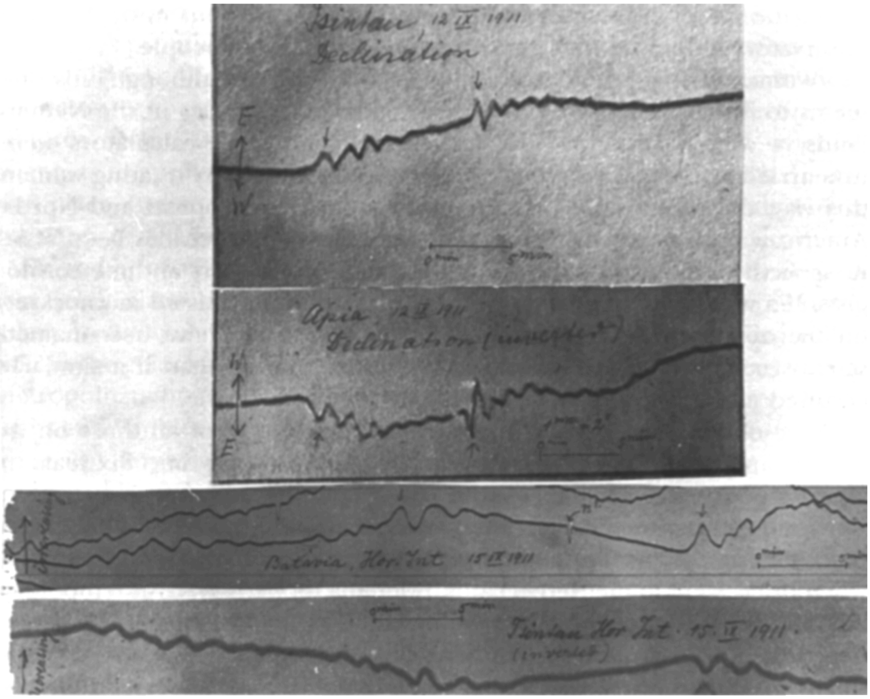
The observatory did not benefit from the services of all those on its payroll, and in this it was typical of colonial service at the time. Six years in a senior position (principal observer or higher) allowed one a sabbatical in Europe. Overseas medical leave was common. There was substantial movement among the personnel, including the director. In 1915, for example, when Braak went to the Netherlands, Boerema took his place as temporary adjunct director and Anna Jean Marie van Vleuten, a native of Weltevreden who was *doctoranda* in mathematics and physics, replaced him as scientist. When Braak arrived back in Batavia and Staverman finally returned from his European leave in 1916 (which presumably had included a medical extension), Boerema reverted to scientist and Van Vleuten headed for the Netherlands and an Utrecht doctorate.[92] In 1917 Staverman left for Europe on medical leave; he never returned. Two years later, when Boerema obtained his sabbatical, the observatory received new scientists: thirty-five-year-old Simon Willem Visser, who had obtained a doctorate under Johannes Petrus Kuenen at Leiden in 1913, and Joan Voûte, the refugee from South African parsimony.[93] In 1920 Van Bemmelen went on leave; he was never again in residence although he continued to hold the directorship until officially turning over the reins to Braak in 1922, upon his retirement. Van Bemmelen's absence had Braak, Boerema, and Visser play musical chairs with various administrative functions. Voûte finally left the observatory payroll in 1923, although for three years he had been devoting all his attention to building the new astronomical observatory at Lembang.

The final major changes in staffing during the period before 1942 occurred in the middle 1920s. Braak became director of a section of the KNMI in 1926, and his position fell, as expected, to Boerema. Twenty-nine-

91 *Bat. Jaarversl. 1919* (1920).

92 Van Vleuten, *Over De Dagelijksche Variatie van het aardmagnetisme* (diss., Univ. Utrecht, 1917), under Ewoud van Everdingen. On Van Vleuten's birthplace: *Album promotorum der Rijksuniversiteit Utrecht 1815-1936* (Leiden, 1963), p. 221.

93 Visser, *Eenige Physische Constanten van normaal butaan* (diss., Univ. Leiden, 1913). On Voûte, see chapter two.



12. Circulation of knowledge in the Pacific. Magnetic storms recorded at Batavia and at the German observatories in Tsingtau (Kiautschou) and Apia (Western Samoa). The top two give declination at Tsingtau and Apia for an event of 12 Sep 1911, the bottom two horizontal intensity at Batavia and Tsingtau for an event of 15 Sep 1911. The Germans and the Dutch exchanged magnetograms beginning in 1905. *CIES*, p. 65. Institut für Geophysik, Göttingen.

year-old Hendrik Petrus Berlage, Jr, who had obtained an engineering diploma and then a doctorate from the Federal Institute of Technology in Zurich for a dissertation on seismology, arrived in 1924 as the junior scientist under Visser. Visser, having been promoted as Boerema's adjunct director, eventually retired in 1934, but financial constraints prevented Berlage from rising to assume the adjunct directorship.[94]

Berlage was the most independent-minded researcher at the observatory during the first half of the twentieth century. He ranged across the entire field of geophysics, from seismology to meteorology, and from the very beginning of his career he pursued an abiding interest in planetary cosmogeny.[95] His appointment at Batavia followed a letter of inquiry on his

94 All personnel changes are chronicled in the annual *Bat. Jaarversl.* When S. W. Visser was made temporary director in 1930 during Boerema's absence, he earned *f* 1200 per month; when Berlage replaced Boerema in the same capacity in 1937, he received *f* 850 per month. BAN, Bt 24 Mar 1930, N° 4, and Bt 13 May 1937, N° 42.

95 F. H. Schmidt, "Levensbericht van Hendrik Petrus Berlage," *Amst. Jaarb.*, 1967-68, *s. v.*

behalf from his father to a prominent engineering professor at the Bandung Institute of Technology.[96] (Berlage senior, a famous Dutch architect and socialist, designed the Koopmansbeurs in Amsterdam and the Gemeentemuseum in The Hague.)[97] Paternal solicitations evoked a strong recommendation from Van Bemmelen, Van Everdingen, and Van der Stok. The three climatologists noted that Berlage had spent a half year at the KNMI, where he came up with original ideas in geophysics and cosmology, and a half year working on seismology with Edmond Rothé in the Institut de physique du globe at Strasbourg; they emphasized that Berlage studied physics under Paul Ehrenfest in Leiden, and that Ehrenfest held him in high regard.[98] Berlage fulfilled the trust placed in him. The official justification for his appointment lay in the need to study atmospheric circulation and its possible relationship to other cosmical phenomena, but he managed to work up numerous theoretical questions in addition to his regular geophysical charges;[99] his calculations appeared in the major Dutch and international journals. Berlage's cosmology saw the light in a colonial imprint, but it originated during his student days at Zurich.[100] Its elaboration testifies to substantial creative leisure at the Batavia observatory during the interwar period. Even in the unlikely event that Berlage's ideas on the origin of the solar system owe something to Javan mythology, his subject is nothing so much as pure learning in a European mold.

Other men occupied the posts of scientist and principal observer along with Berlage. Cyprianus Annius van den Bosch arrived as a scientist in 1927 with a freshly minted doctorate in planetary astronomy from Nijland at Utrecht, although three years later he graduated to a post as a teacher in the Soerabaja HBS.[101] His replacement was Guillaume Paul Nijhoff, a graduate of Willem Hendrik Keesom's at the Leiden low-temperature laboratory; Nijhoff continued measurements of atmospheric potentials undertaken by Van den Bosch and then died in 1932.[102] When

96 BAN, BGS, 2 Jan 1926, N° 1. Afschrift Nota 30 Jan 1925, by Braak, where Braak cites Berlage Sr's query to the professor of mechanics, J. Klopper, about a position for Berlage Jr in the government service.

97 Jan Romein, transl. Arnold J. Pomerans, *The Watershed of Two Eras: Europe in 1900* (Middletown, Ct., 1978), p. 570; E. H. Kossmann, *The Low Countries, 1780-1940* (Oxford, 1978), p. 450. J. Bot, "Bouwkunst," in *Geestelijk Nederland 1920-1940*, ed. K. Proost and Jan Romein, 2 vols (Amsterdam, [1948]), *1*, 167-210, for Berlage Sr in context.

98 BAN, BGS, 2 Jan 1926, N° 1. Van Bemmelen, Van Everdingen, and Van der Stok to Colonial Minister, 8 Nov 1924 (copy).

99 *Ibid.* Naval Commandant to Governor General, 13 Mar 1925, where the justification for hiring Berlage is given.

100 Berlage, "De Ontwikkelingsgeschiedenis der planeten vanuit een nieuwe gezichtspunt," *NT, 87* (1929), 205-19. The European origin of Berlage's cosmological interest: F. H. Schmidt, "Berlage" [note 95].

101 Van den Bosch, *De Massa's van de groote planeten* (diss., Univ. Utrecht, 1927); *Bat. Jaarversl. 1930.*

102 *Bat. Jaarversl. 1932.*; Nijhoff, *Metingen van den tweeden viraalcoëfficient van zuurstof, waterstof en helium bij lage temperaturen* (diss., Univ. Leiden, 1928); Nijhoff, "Potentiaal Metingen te Batavia," *6° NINC Hand.* (1931), pp. 189-95.

finances began to improve late in the 1930s, three new men arrived as scientists: Machiel Willem Frederik Schregardus in 1937, Herman Johannes de Boer in 1938, and Gerardus Harmannus Klamer in 1939. All three had recently completed physics doctorates, none of these at Leiden or Amsterdam.[103] Their research was not insignificant, although fortune did not provide them an auspicious time to begin a scientific career.[104] The Batavia observatory, evidentally, had become a place of refuge for young scientists from the less prestigious Dutch universities.

Van Bemmelen's legacy provided Batavian geophysicists with enviable posts. Salaries more than covered the cost of living. Unlike the case at many sister institutions, the observatory and its director did not oblige the senior staff to devote all their energies toward providing the colonial navy with climatological tables and charts. Scientists could undertake projects in related areas and, especially, publish their findings in colonial and international journals. Resources for such epicyclical enterprises, however, were lacking. Berlage used his spare time to elaborate theoretical cosmogeny. His younger colleague Van den Bosch jumped into vulcanology and quickly became embroiled in a long-running dispute, appearing in the *Natuurkundig Tijdschrift voor Nederlandsch-Indië*, with a geologist colleague. The controversy did little to enhance Van den Bosch's credentials as a researcher, and it may have been a contributing factor in his decision to accept a position outside Batavia.[105]

A welcoming address delivered by Van Bemmelen at the first Netherlands Indies Scientific Congress in 1919 provides a picture of his organizational strategy. Over the past decades, he emphasized, scientific life in the East Indies had been bound up with questions of agricultural cultivation. The scientific congress, however, was for researchers involved in pure learning "unrelated to the spheres where their results are applied." It reflected the "growth of idealism in the Indies, on the one hand, and the broadening of intellectual life, on the other." Applications could not emerge without "actual scientific insight":

103 Schregardus, *De Geigerteller en zijn bruikbaarheid voor intensiteitsmetingen*. . . (diss., Univ. Utrecht, 1936), under L. S. Ornstein; De Boer, *Over Het Gladstrijken van krommen* (diss., Univ. Groningen, 1936), under F. Zernicke; Klamer, *Fine Structure of X-Ray Absorption Edges of Molecular Gases* (diss., Univ. Groningen, 1938), under D. Coster.

104 Schregardus, *Sea Surface Temperatures on Some Steamer Routes in Netherlands India (Third Series 1933-1937)* (Batavia, 1938) [*Bat. Verh.*, N° 28]; De Boer, *On the Physical Reality of Some Long Periodic Cycles in the Barometric Pressure of Batavia* (Batavia, 1941) [*Bat. Verh.*, N° 29].

105 C. A. van den Bosch, "De Wordingsgeschiedenis van het Tenggergebergte," *NT*, *89* (1929), 389-436, where Van den Bosch proposes the origin of a volcanic crater. His Dutch opponent: C. G. S. Sandberg, "Over Een Nieuwen Grondslag ter verklaring van het calderaprobleem," *Amst. Proc.*, *31* (1928), 179-98; 199-207; "De Caldera-Strijdvraag," *NT*, *90* (1930), 304-10; "Het Zoogenaamde Caldera-Probleem," *Geologie en mijnbouw*, *10* (1931), 83-9, 92-4, 107-9, 118-21; "Kritische Betrachtungen zum Caldera-Problem," *Zeitschrift der Deutschen Geologischen Gesellschaft*, *82* (1930), 142-72. Van den Bosch, "Nog Eens: De calderavorming," *NT*, *91* (1931), 118-27, and the exchange between Van den Bosch and Sandberg in *NT*, *92* (1932), 25-38.

13. Willem van Bemmelen. Department of Terrestrial Magnetism, Carnegie Institution of Washington.

I should like to call to those in power and in administrative positions: Honor and continue to recognize the great value of purely scientific research and of its indispensable satellites [*trawanten*], encyclopedic and bibliographic work.

One new discovery can be more effective than ten researches decreed in official *schrijftafellakten*.

Van Bemmelen reminded his listeners that "original minds required freedom of action." He listed a number of problems that could be addressed by researchers given free rein, and he indicated a pantheon of scientists who had passed through the Indies to act in the proper fashion. Scientific reason and self-cricitism would be able to dispel the credulity endemic to the colony. Scientists brought together to discuss their research directed attention to higher aims in "these times that are poisoned by hate." Van Bemmelen stated as an article of faith: "Pure learning knows no borders."[106]

Van Bemmelen intended his high-minded rhetoric for Governor General Johannes Paulus graaf van Limburg Stirum, who sat in the audience. He concluded with the thought that "scientific workers desire to live in harmony with their patrons." The message, as we shall see in chapter four, had already been assimilated into ambitious plans for institutions of higher education. It may be stated simply. The scientific community, in carrying on with pure learning, would provide practical and moral instruction to the colony.

## Limitations of Pure Learning in a Colonial Setting

As they prosecuted pure learning, the Batavia geophysicists also satisfied the wants of the colonial naval departement. Each of the observatory directors, beginning with Bergsma, acquiesced to the notion of a dual mandate, but during the nineteenth century, advancing pure research took the form of constructing a scientific infrastructure—in both matériel and personnel. When Van Bemmelen completed the infrastructure, all his equipment required the full attention of his staff. Serving both Athena and Poseidon meant inhibiting large research programs in areas not already represented at the observatory.

Nothing is clearer in this regard than the treatment accorded Voûte during his four years as an observatory scientist. Astronomy might well have formed a division of the Batavia operation, but Van Bemmelen opposed this idea as soon as it took shape between Voûte and K. A. R. Bosscha. Van Bemmelen was nearing the end of his colonial service. His own research had produced respectable if unremarkable publications in terrestrial magnetism and atmospheric physics; his program for the upper atmosphere had yielded little fruit. The idea of an ambitious new project filled him with anxiety.[107] Van Bemmelen supervised, for nearly twenty years, the scientific apprenticeship of Bosscha, who by 1914 had erected a seismograph at his tea estate and was receiving a weekly time signal from

106 Van Bemmelen, "Openingsrede van den algemeenen voorzitter," *1° NINC Hand.* (1920), pp. 1-6, quotations on pp. 2-5.

107 Van Bemmelen wanted to find a position to which he could retire in Europe or North America. In 1922 he became *lector* for physical geography at the University of Amsterdam. *CIES*, p. 123, for Van Bemmelen's search.

Batavia.[108] Any observatory that Bosscha endowed in the mountains of Java, Van Bemmelen realized, would dwarf his own; appending it to the Batavia institution would be to have the tail wag the dog.

The tail, by 1920, had been carefully groomed by the colonial government. Bandung, the general area in Western Java where Bosscha's observatory would be erected, had become a favored haunt of the administrators, who were planning to invest it with new institutions and annexes of the bureaucracy, including an institute of technology, a law school, and the bureau of mines. In the words of the Council of the Indies, Bandung had become the future "scientific center" of the colony.[109] Van Bemmelen hoped that his observatory would be transplanted to a new setting in Bandung, he wrote to his superior Naval Commandant W. J. G. Umbgrove in 1920, because his own campus had declined in utility. His observatory needed more room and greater isolation from mechanical and electromagnetic disturbances, he continued; for *f* 260,000 suitable buildings could be erected at the new site. He preferred this solution to spending a comparable sum on new construction in Batavia.[110] He persuaded both his temporary successor Braak and also Umbgrove to support the project. Umbgrove indicated to the governor general that if the observatory received no new investment, it would decline to the level of "a third-rank institution."[111] The Royal Magnetical and Meteorological Observatory remained at Batavia without receiving a massive infusion of funds, a circumstance that is less surprising in view of its dependence on the navy.[112]

It is easy to imagine that astronomy in Indonesia would have ranged farther and deeper if the Bosscha observatory had been, from the beginning, an affiliate of the Batavia geophysicists. Yet the resolution of this question, as that of the relocation of the Weltevreden campus, followed from elaboration of the observatory's dual mandate to investigate both pure and applied science. For more than half a century, directors had emphasized the dual mandate as a strategy for institutional growth. With the endowment of major institutions for pure science, the demands of the dual mandate slowed progress in both the pure and applied directions.

Van Bemmelen's immediate successor Braak tugged at restrictions imposed by the dual mandate. When Voûte finally left the observatory's payroll in 1923, a call went out to fill his position. Braak and the naval commandant wanted a young physicist from the Netherlands. The colonial

108 *Bat. Jaarversl. 1914* (1915), p. 8.

109 BAN, BGS 10 Feb 1922, N° 383/III D. Advies van den Raad van Nederlandsch-Indië, 1 Oct 1920.

110 *Ibid.* Van Bemmelen to Naval Commandant, 20 Mar 1920.

111 *Ibid.* Braak to Naval Commandant, 10 Mar 1921, on the requirements for a Bandung campus; Naval Commandant to Governor General, 19 Aug 1921, for quotation.

112 BAN, BGS, 2 Jan 1926, N° 1. Memorandum of the Algemeene Secretarie on the vacancy of the second *wetenschappelijk medewerker* post, 12 May 1924. Senior staff at the Batavia observatory remained essentially constant between 1914 and 1924, and the total budget increased in this period from *f* 136,427 to *f* 158,760.

secretariat, however, insisted that candidates first be sought among government research installations in Indonesia.[113] The observatory staff would not engage local talent. They had the naval commandant prepare a long description of the observatory's difficult tasks, high reputation, and insufficient funding.[114] The government entertained the navy's plea, but it wanted practical utility to result from having gone to Europe for a new man. Following the advice of the director of the departement of agriculture, health, and commerce, the government finally authorized a position for an expert in "agroclimatology."[115] The geophysicists extolled H. P. Berlage's multifaceted talents to have him pass as an agricultural climatologist.

The conflicting demands of two masters—the spiritual and the temporal—also suggest why the Batavia observatory failed to enter into the most vibrant areas of geophysically related research during the 1920s. One of these areas concerned cosmic rays—their nature, origin, and utility in lieu of a high-energy particle beam. In their relative neglect of cosmic rays, the Batavia geophysicists followed the lead of metropolitan colleagues: Cosmic rays, in the 1920s and 1930s, belonged to the province of university-based physicists, and, as we shall see shortly, the Dutch pioneer of cosmic-ray research honed his techniques while a professor at the Bandung Institute of Technology.

This chapter concludes by considering two areas of geophysical research in which the Batavia observatory did not become actively involved. The first area concerns ultraviolet sunlight in the tropics, the second submarine gravimetry. In each case researchers undertook significant observations throughout the Malay archipelago. The observations verified contentious or inconclusive propositions. The observers enjoyed distinguished careers despite critical readings of their data by German and Dutch colleagues.

## *Ultraviolet Illumination*

During his tenure as director, Braak devoted his most intense efforts toward writing a multivolume treatise on Indonesian climatology.[116] Braak's understudy and successor, Boerema, focused for the most part on rainfall. Like many of his predecessors and colonial colleagues, Boerema wanted to keep his hand in research of a pure nature. When the local medical school

113 *Ibid.* Naval Commandant, *verslag* of 24 Apr 1923, N° 1, about replacing Voûte with someone from the Netherlands; BGS 16 May 1923, N° 1203/III D, where the government prefers to fill the post with local talent.

114 *Ibid.* Naval Commandant to Governor General, 14 Mar 1924. The unacceptable local candidate was Johannes Jacobus Feijtes. Feijtes to Braak, 4 Jun 1923.

115 *Ibid.* Director of Agriculture, Health, and Commerce, "Agroklimatologisch Onderzoek bij het Koninklijk Magnetisch- en Meteorologisch Observatorium," memorandum of 13 Jun 1924; Bt 13 Sep 1924, N° 21, authorizing a post of *wetenschappelijk medewerker* in the area of "agroclimatology."

116 Braak, *Het Klimaat van Nederlandsch-Indië*, 2 vols, 11 parts (Jakarta, 1921-1929) [*Bat. Verh.*, N° 8].

became a university-style faculty in 1927, Boerema, as the senior physicist in town, found an appointment there as associate professor of physics; with the appointment came, in addition to a professorial title, a laboratory and an assistant.[117] Boerema had the example before him of Van Bemmelen, who traded in a fact-collecting program of research on the upper atmosphere for a university post in the metropolis. With the resources of a large observatory, and having achieved through *cumulation* a base of operations at a faculty, Boerema anticipated a grand future in atmospheric research.

Boerema decided to focus on measuring ultraviolet radiation in tropical sunlight. His research program related to a traditional concern at the observatory for predicting the weather, but it went beyond simple empiricism.[118] British and French researchers (Robert John Strutt and Alfred Fowler; Charles Fabry and Henri Buisson) had pointed to the presence of ozone in the upper atmosphere and identified its role in absorbing ultraviolet radiation.[119] Of special interest, then, would be to compare tropical ultraviolet penetration with that of other latitudes, for the result bore directly on the physics of the upper atmosphere and the character of the ozone layer. In a paper of 1919, Boerema did just that and concluded, from pyrheliometrical observations, that for equal solar altitudes Batavia received less radiation than Washington.[120]

The research program advanced through the labors of Maarten Pieter Vrij, Boerema's assistant at the medical school. The first publication appeared in 1929. Boerema and Vrij used a small quartz spectrograph to photograph the sun's spectrum. They announced qualitative results in favor of substantial ultraviolet penetration, in agreement with recent calculations showing that the ozone layer over the tropics was 70% of its value in temperate zones.[121] A second publication presented the findings to the 1930 meeting of the International Union of Geodesy and Geophysics in Stockholm.[122]

117 That Boerema was in at the beginning is confirmed in the report of the dean of the faculty, J. Boeke, in Jakarta, Geneeskundige Hoogeschool te Batavia, *Eerste Jaarboekje* (Weltevreden, 1928), p. 62.

118 Boerema, "Seasonal Forecast on Java," National Research Council of Japan, *Proceedings of the Third Pan-Pacific Science Congress, Tokyo, October 30th-November 11th 1926* (Tokyo, 1928), *2*, 1364-6, where the research of Berlage is summarized.

119 In *DSB*, *s. v.*: "Strutt" and "Fabry." The early history of the question is recounted in Maarten Pieter Vrij, *Vergelijkende Metingen van ultraviolette zonnestraling in de tropen en in Europa* (diss., Univ. Amsterdam, 1932), pp. 1-9. Summaries in: Frederick E. Fowle, *Atmospheric Ozone: Its Relation to Some Solar and Terrestrial Phenomena* (Washington, 1929) [*Smithsonian Miscellaneous Collections*, *81*, 11]; Charles Fabry, J. Gauzit, Daniel Chalonge, and Etienne Vassy, *Propriétés optiques de l'ozone et leur emploi dans l'étude de l'atmosphère* (Paris, 1934); and the Francophile historical sketch by Fabry, *L'Ozone atmosphérique* (Paris, 1950), pp. 7-12.

120 Boerema, "Intensiteit der zonnestraling," *1° NINC Hand.* (1919), pp. 99-101.

121 Boerema and Vrij, "Ultra-Violet in Tropical Sunlight," Jakarta, Netherlands Indies Science Council, *Proceedings of the Fourth Pacific Science Congress, Java 1929* (Jakarta/Bandung, 1930), *2B*, 857-61. Following the custom of the time, Boerema and Vrij also had the paper appear in the *Amst. Proc.*, *32* (1929), 435-9.

122 Boerema, "Ultraviolet Solar Radiation on Java," International Union of Geodesy and

Boerema and Vrij's research attracted immediate attention in Europe. Potsdam astrophysicist Walter Grotrian (who had passed through Batavia as part of the German eclipse expedition of 1928-29) abstracted their findings in the leading broad-spectrum German scientific journal.[123] Grotrian's rapportage brought a long critique by Carl Dorno, the biometeorologist who for decades had been observing solar radiation in Switzerland and whose data received notice by the Batavian geophysicists. Dorno pointed out the unreliability of Boerema and Vrij's results, and the multiple factors—meteorological and physical—that they had omitted, for example, separating secondary cosmic-ray penetration from ultraviolet radiation of solar origin.[124]

Boerema's predecessor Braak had in 1926 come to precisely the opposite conclusion—that the record of tropical photography (where exposure times were longer than in temperate climates) indicated relatively slight penetration of ultraviolet radiation.[125] Braak had been a student in Kamerlingh Onnes's laboratory alongside Jacob Clay and Tettje Clay-Jolles;[126] in the 1920s Jacob held forth as the professor of physics, and his wife drew a salary as his assistant, at the new Bandung Institute of Technology. Jacob, as we shall see in chapter four, was engaged in measuring cosmic-ray radiation. The Clays decided that Braak's guess had more merit than the observations of Boerema and Vrij. In 1928 Tettje Clay-Jolles began a systematic study of ultraviolet radiation at Bandung by means of the electrometric discharge of a cadmium cell. Jacob Clay received a call to the chair of physics at the University of Amsterdam in 1929. Before leaving, he and his wife each spoke about the sunlight data.[127] According to Tettje Clay-Jolles, for equal solar altitudes ultraviolet radiation was much stronger in Bandung than in the highlands of Switzerland.[128]

The Clays' work-in-progress on solar radiation, as well as Jacob Clay's discovery of the variation of cosmic-ray intensity with latitude, figured in Dorno's comments on Boerema and Vrij's undertaking. In 1932 the Clays finally published the results of their ultraviolet research. They followed the method of F. Paul Götz at Arosa for determining the relative thickness of

Geophysics, Fourth General Assembly, *Procès-Verbaux, section météorologie* (Stockholm, 1930), pp. 97-101.

123 Grotrian, "Die ultraviolette Sonnenstrahlung in tropischen Gegenden," *Naturwissenschaften, 18* (1930), 22-3.

124 Dorno, "Die ultraviolette Sonnen- und Himmelsstrahlung in tropischen Gegenden," *Naturwissenschaften, 18* (1930), 249-52. "Dorno," *DSB, s. v.*

125 Braak, *Klimaat* [note 116], p. 121 of the appended English summary.

126 Jacob Clay defended his dissertation two months after Braak's thesis defense, and he acknowledged Braak's help. Braak, *Isothermen* [note 81]; Clay, *De Galvanische Weerstand van metalen en legeeringen bij lage temperaturen* (diss., Univ. Leiden, 1908), p. 3.

127 A report on Jacob Clay's lecture to the Koninklijke Natuurkundige Vereeniging about solar radiation in the tropics appeared in *Preangerbode*, 4 Sep 1929; the report is cited in Maarten P. Vrij, "Problemen bij het fotografeeren in de tropen," *NT, 90* (1930), 234-42, on p. 234.

128 Extracts from Clay-Jolles's lecture to the Koninklijke Natuurkundige Vereeniging in September 1929 appear in Denis Mulder, *Malaria* (The Hague/Bandung, 1931), pp. 85-6.

the ozone layer (the ratio of unfiltered to filtered radiation being proportional to the length of the path in the ozone); according to their calculations, the ozone layer above Bandung depended on the season, varying between 68% and 92% that above Davos. After carrying out other calculations of horizontal illumination, the Clays addressed the vexacious question of tropical photography. Ultraviolet, they noted, was absorbed by photographic lenses. In photography one mostly took pictures of vertical planes illuminated by the sun; this "front light" was weak in the tropics, especially around noon, because of the high altitude of the sun.[129]

Now in 1930, Vrij had examined the extent to which the experiences of amateur photographers supported his and Boerema's case; he concluded that they did not, for the same reasons as given by the Clays.[130] Vrij spoke on his research before the sixth Netherlands Indies Scientific Congress in 1931. There he reiterated his claim, based on cadmium-cell measurements, that the tropics received more ultraviolet than the temperate latitudes. After his talk, Vrij fielded a question from the Batavia professor of radiology, Bernardus Jan van der Plaats, about whether the physicists at Utrecht had any information regarding ultraviolet penetration of the earth's atmosphere (before becoming a physician, Van der Plaats had taken a doctorate under the Utrecht solar physicist Willem Henri Julius); Vrij knew of nothing from Utrecht. The brief exchange suggests the extent to which ultraviolet radiation concerned marginally situated physicists.[131]

Four months after the Clays presented their detailed conclusions to the world, Vrij defended his doctoral dissertation at the University of Amsterdam on a comparison of ultraviolet radiation in the tropics and in Europe.[132] He wrote it while working for Boerema at the Batavia medical school. His pro-forma adviser was Pieter Zeeman, Clay's theoretician colleague. Neither Zeeman nor Boerema, however, seems to have exercised much control over the final product. The text is the work of a *thésard* without a proper adviser. It considers the general question of ozone in the atmosphere and the measurement of ultraviolet solar radiation. Then it reports on measurements made with both a spectrograph and a photoelectric cell. Vrij concluded that ultraviolet penetration at sea level was much greater in the tropics than in Europe, but at higher altitudes the penetration was equivalent.

Who was right—Vrij, Boerema, and Zeeman, or the Clays? The junior partners went after each other in a peripheral journal. Tettje Clay-Jolles defended her research in a discussion published in the *Natuurkundig*

129 Jacob Clay and Tettje Clay-Jolles, "Measurements of Ultraviolet Sunlight in the Tropics," *Amst. Proc.*, *35*, pt 1 (1933), 69-82, 172-85.

130 Vrij, "Problemen bij het fotografeeren in de tropen," *NT*, *90* (1930), 234-42. Vrij cites his work and Clay's as both supporting the view that there is much more ultraviolet light in the tropics than previously thought.

131 Vrij, "Over Ultra-Violette Straling en haar meting," *6° NINC Hand.* (1931), pp. 158-67. A report of discussion follows the text of Vrij's paper.

132 Vrij, *Vergelijkende Metingen* [note 119].

*Tijdschrift voor Nederlandsch-Indië*. She noted that researchers had shown that the ozone layer increased at higher latitudes, and from this conclusion one might well have expected to find large ultraviolet penetration in the tropics, although account had always to be taken of differing solar altitudes. She found Vrij's conclusions unaccepable. The problem lay in his experimental technique: He had been unable to record usable data with a filter, he was cavalier about exposure times, he did not take sufficient care to correct for season and height above sea level, and he confused the recording of the photoelectric cell with ultraviolet intensity as such.[133] Vrij's reply followed directly. Clay-Jolles's criticisms, in his view, were mostly speculative theorizing.[134]

It is no surprise that the question of ultraviolet solar radiation received attention from Batavia's polymath, H. P. Berlage. In 1935 he summarized nearly a generation of intermittent recording by the staff of the Batavia observatory. For equal altitudes of the sun, he concluded, Batavia received about 10% less radiation than Washington.[135] Berlage and his captain Boerema continued observing. They published a final report during the height of the revolutionary war in 1948, which, although it contained much data on total radiation penetration, did not settle the debate of twenty years' standing.[136] As is frequently the case in science, this controversy ended without definitive resolution.

Berlage's dedication is also manifest in the most prolific researcher on atmospheric electricity, Johannes Pieter Hendrik de Kruijff, who was the physics teacher at the medical school in Soerabaja. De Kruijff followed Pieter Zeeman's urging and began observing atmospheric electricity around 1923, becoming a masterful seer of the tropical skies.[137] The reams of data that he recorded, like that data recorded faithfully by Berlage, Boerema, and Vrij, find few counterparts in the world of science. The Dutch geophysicists worked in colonial settings with a rare intensity that stemmed from an imperative to understand the world in general terms.

133 Clay-Jolles, "Vergelijking van het ultraviolet zonlicht op Java en in Europa," *NT*, *93* (1933), 126-38.

134 Vrij, "Eenige Opmerkingen naar aanleiding van het artikel van Mevr. Clay-Jolles," *Ibid.*, pp. 138-41, followed by concluding remarks of Clay-Jolles's, pp. 141-2.

135 Berlage, "Measurements of Solar Radiation at Different Stations in Netherlands India during the Past 20 Years," 7° *NINC Hand.* (1935), pp. 73-4 (abstract and discussion).

136 Boerema and Berlage, *Solar Radiation Measurements in the Netherlands Indies* (Soerabaja, [1948]) [*Bat. Verh.*, N° 34]. Boerema authored part one, "Pyrheliometric Observations by Eye-Reading from 1915-1925"; Berlage authored part two, "Recording Radiation of Sun and Sky from 1926-1941"; part three consists of data tables.

137 De Kruijff, "Metingen van het specifiek atmosferische geleidingsvermogen met het toestel van Gerdien te Lawang en te Soerabaja," *NT*, *89* (1929), 469-97, 498-505, where Clay's help is acknowledged; his measurements continued in *NT*, *90* (1930), 74-7; *91* (1931), 78-92. De Kruijff, "Bepaling van het aantal kleine ionen in en het specifiek electrisch geleidingsvermogen van de atmosfeer te Lawang," 6° *NINC Hand.* (1931), pp. 143-57; De Kruijff, "Drie Jaar Luchtpotentiaalmeting aan de Ned. Ind. Artsenschool te Soerabaja," 7° *NINC Hand.* (1935), pp. 83-92. De Kruyff [*sic*], *Metingen betreffende de luchtelectriciteit te Soerabaja en te Lawang (Oost-Java)* (diss., Univ. Amsterdam, 1933). On Zeeman's influence: *Eeuw*, p. 35.

Knowledge was global, not local. Inventories taken in one corner of the natural world served the ends of abstract theory, not those of mercenary application. In atmospheric physics, one had to compare the tropics with the temperate zone. We shall see in chapter four that this instantiation of the research ethic led to Jacob Clay's discovery of the latitude effect in cosmic rays.

*Gravimetry and Isostasy*

Geophysicists directed attention, late in the nineteenth century, to the figure of the earth—the extent to which the globe departed from a perfect sphere. Much of the interest arose in the context of mapping programs, both within the borders of the major North-Atlantic powers and, as in the case of J. A. C. Oudemans's survey of the Malay archipelago, in colonial settings. The principal technique consisted of chain-and-rod traverses of great-circle arcs, which could be compared against longitude determination by astronomical means; gravimetric measurements, like those by Oudemans, sometimes found their way to the list of a surveyor's tasks. This line of research evidentally allowed academic researchers to profit from metropolitan interest in surveying imperial property, and it offered ministries of war a means of penetrating independent countries under the guise of a program to advance human knowledge.[138] The expensive and time-consuming topographical research programs lost support during and after the First World War. The military establishments of the belligerent powers, who were the principal patrons of the endeavor, had their attention focused elsewhere.

The history of geodesy and geophysics, no less than of physics itself, is marked by the progress of scientific instrumentation. It fell to Felix Andries Vening Meinesz, an engineer in the Dutch Commission for Geodesy and Water-Levels (Rijkscommisie voor Graadmeting en Waterpassing), to bring geodesy and geophysics to bear on dynamic geology. He did so by designing a sensitive gravimetric pendulum.

Measurements of the regional variation of the acceleration due to gravity may be traced out in a thread across the second part of the nineteenth century. The fundamental physical constant could be determined to great precision in the new physical laboratories that sprouted up in Europe and North America, and local variation of $g$ pointed to deposits of metallic ore. The measurements also contributed to ongoing discussions about mountain building and the physical constitution of the earth's crust. Geologists generally believed that the crust floated, in isostatic equilibrium, on an underlying bed of molten lava; the task remained to explain

138 On Oudemans, chapter two; on the figure of the earth with special reference to the French in Ecuador, Lewis Pyenson, "Ciencia pura y hegemonía política: Investigadores franceses y alemanes en Latinoamérica," in *Historia de la ciencia*, eds Antonio Lafuenta and Juan José Saldaña (Madrid, 1987), pp. 195-215, esp. pp. 200-203.

the statics of mountains and ocean basins, and, for this, density measurements were essential.[139]

Felix Andries Meinesz (the family name officially became Vening Meinesz in 1893) was the son of the mayor of Rotterdam and afterwards Amsterdam. He graduated from an Amsterdam HBS and obtained an engineering diploma from the Delft Institute of Technology in 1910. Upon graduation he signed on with the geodesical commission to assist in carrying out a gravimetric survey of the Netherlands. At many of the stations, Dutch soil refused to provide a stable base for setting up gravity pendulums. Vening Meinesz solved the problem by mounting two isocronous pendulums in the same plane and setting them swinging with opposite phases; the mean of the two periods would be immune to first-order disturbances. The theoretical innovation appeared as his doctorate of engineering in 1915. By 1921 he had used the new instrument to complete the commission's survey.[140]

At this time a number of gravimetric surveys had generally supported the isostatic hypothesis, but gravity measurements for the oceans were—with the presumed exception of those taken on polar shelf ice—unknown. Vening Meinesz, whose independent means allowed him to push the limits of his government appointment away from practical tasks and toward pure learning, first thought to mount his vibration-free pendulums on a ship. An attempt in May 1922 failed due to accelerations caused by surface waves. The director of the Dutch mining commission, Frederik Karel Theodoor van Iterson, then suggested to Vening Meinesz that if one could carry the apparatus beneath the surface, the effect of the waves would be damped to insignificance. The Dutch navy had a submarine corps ready to assist.[141]

The same as the other belligerent and neutral powers, the Netherlands began to deploy submarines during the first decades of the twentieth century. By war's end a handful were in active service. These varied from an obsolete 67-foot long boat commissioned in 1905 and capable of ranging 400 miles on the surface, to an ocean-going menace with multiple torpedo

139 W. A. Heiskanen and F. A. Vening Meinesz, *The Earth and Its Gravity Field* (New York, 1958), pp. 124-46.

140 "Meinesz," *BWN*, *s. v.*; "Vening Meinesz," *DSB*, *s. v.*; W. Nieuwenkamp, "Felix Andries Vening Meinesz," *Amst. Jaarb.*, 1966-67, pp. 364-70; B. J. Collette, "In Memoriam Professor Dr Ir Felix Andries Vening Meinesz," *Geologie en mijnbouw*, *45* (1966), 285-90; Veldkamp, *History* [note 74], pp. 83-95; J. Veldkamp, "De Betekenis van Felix Andries Vening Meinesz voor geologie en geofysica," *Zenit*, *14* (1987), 50-8; Rachel Laudan, "Oceanography and Geophysical Theory in the First Half of the Twentieth Century: The Dutch School," in *Oceanography: The Past*, eds Mary Sears and Daniel Merriman (New York, 1980), pp. 656-66. The earliest synthetic reporting on Vening Meinesz's work is found in "Géodésie," appearing in *Développement*, pp. 34-40, esp. pp. 36-9. The most complete account is found in G. J. Bruins, "Professor dr ir F. A. Vening Meinesz; bij de herdenking van zijn 100e geboortejaar," *Geodesia: Nederlands geodetisch tijdschrift*, *29* (1987), 442-56, which directs special attention to instrumentation.

141 Vening Meinesz, *Observations de pendule sur la mer pendant un voyage en sous-marin de Hollande à Java 1923* (Delft, [1924]) [Rijkscommissie voor Graadmetingen en Waterpassing, *separatum* for the Madrid congress of the International Union of Geodesy and Geophysics], p. 1.

tubes and a range of many thousands of miles. In principle the submarines were distributed between Europe and the East Indies; in practice too few had entered service, by 1918, to allow for a submarine pack both in the Indies and at home.[142] This poverty caused great concern among the naval general staff. Between 1920 and 1922, as four more submarines entered service, the general staff drafted an ambitious plan to provide, among other things, sixteen submarines for the motherland and 32 submarines for the Indies. The naval bill stemming from the plan received extraordinary and empassioned attention by a committee of the Dutch second chamber, who pared it to size in the summer of 1923: Ten submarines would have to do for the Netherlands, and sixteen for the Indies. The bill came to a vote late in October. Parliamentary whips carried in ailing and one dying deputy to cast their vote. The proposal went down to defeat, 50 to 49. This decision determined the course of the Dutch navy over the next fifteen years.[143]

A philosophically-minded commentator has noted, without elaboration, the "obvious practical and political reasons for a Dutch geophysicist" to choose to carry out a submarine gravimetric survey of the East Indies.[144] The observation is insufficient to explain why this particular geophysicist received such a generous reception by the financially strapped navy. It is not unreasonable to suppose that the navy assisted Vening Meinesz's first expedition as a publicity stunt to gain support for the naval bill. Vening Meinesz's family connections in political circles propelled him to become the expedition's leader; his diplomatic personal qualities guaranteed additional support required for success.[145] He set off for the Indies, weeks before the crucial vote on the naval bill, without having proved that his

142 *Jane's Fighting Ships 1919*, eds O. Parkes and Maurice Prendergast ([London], 1919; 1969), pp. 414-15, for an optimistic figure of around sixteen deployed. A. N. baron de Vos van Steenwijk, *Het Marinebeleid in de tweede wereldoorlog* (Amsterdam/Dieren, 1986), p. 14, gives the figure of eight in 1922. On the sequence of commissioning the submarines: C. von der Linden and M. S. Wytema, *Met Hr. Ms. KXIII naar Nederlandsch-Indië: Een onderzeeboottocht van meer dan 20,000 zeemijlen* (Amsterdam, [1927]), pp. 15-17. Before the end of 1923, there were only two submarines in the colonial service, according to L. L. von Münching, *Schepen van de Koninklijke Marine in de tweede wereldoorlog* (Alkmaar, 1978), p. 41. The definitive, collective work, *Wegduiken. . .! De Nederlandse Onderzeedienst 1906-1966* (The Hague, [1967]) is clear that ten submarines had been commissioned by war's end (p. 600), and five submarines were in active service in the East Indies by 1922 (p. 332).

143 For the parliamentary drama, De Vos van Steenwijk, *Marinebeleid* [note 142], pp. 14-17, and *Wegduiken* [note 142], pp. 62-80 (by C. J. W. van Waning).

144 Lauden, "Oceanography" [note 140], p. 658.

145 DRG. Naval Minister to Vening Meinesz, 31 Jul 1923, N° 3033, where the minister writes: ". . . your plan to take part in the voyage of Hr. Ms. K II to the Indies has my support." This, taken together with the absence of any other correspondence on the matter, suggests that Vening Meinesz negotiated directly with the naval ministry instead of going through the commission. The minister billed Vening Meinesz for dining in the officers' mess during the voyage. Such an interpretation finds support from the recollections of G. J. Bruins: "Mostly Vening Meinesz prepared the expeditions by a personal visit to the Minister of Marine or to his second man (staatssecretaris). After World War II, I accompanied him sometimes during such a visit. After that the official letters followed." G. J. Bruins to the author, 19 Jan 1988.

instrument would in fact work at sea.[146]

Vening Meinesz mounted his pendulums aboard the submarine K II. Commissioned early in the war and with a range of 3500 miles, it belonged to a new class of long and advanced boats, although its 177 feet were dwarfed by a number of British leviathans. K II was one of three submarines convoyed to the East Indies by a surface support vessel.[147] Running from Den Helder to Gibraltar, Vening Meinesz realized that if he were to obtain useful data the pendulum would have to be surrounded by a cradle to counteract the boat's roll. The modification came courtesy of the British admiralty in Gibraltar for the price of £ 30. He continued on through Suez, reaching Batavia the day before Christmas 1923. He returned home on a surface liner and worked up 32 submarine observations.[148]

The navy received favorable publicity from the expedition, and Vening Meinesz's superiors had nothing much to occupy him with at home. It was to everyone's advantage that the expeditions be continued. Vening Meinesz accordingly travelled to the Indies by submarine in 1926-27, 1929-30, and 1934-35, carrying out over 600 gravity determinations, and he undertook a number of similar expeditions in the Mediterranean, the Atlantic, and (with the cooperation of the United States navy) the Caribbean. His boats were the top of the line. In 1926, for example, he travelled in K XIII to Panama and on to the Indies, the first time that a Dutch submarine crossed the ocean without a surface tender.[149] All three of the Indian trips used vessels attached to the colonial navy. Vening Meinesz retained a salary as a member of the geodesical commission, at least until he became an associate professor at Utrecht in 1927.

The submarine data went to verify Vening Meinesz's theory of modified isostasy, which took into account the mechanical characteristics of the crust. He found anomalous negative-gravity belts along various island arcs—the *minos* zones, as they became known by a *double-entendre*—both sides of which had fields of positive anomalies. To explain these anomalies, Vening Meinesz took careful account of the marine depth soundings made by the "Snellius" expedition sent out by the KNMI in 1929-30, and, as well,

146 "Géodésie," *Développement*, p. 37, mentions only the positive results of the pendulum "en rade du Helder," that is, at the naval base Den Helder, before Vening Meinesz set off for the Indies. Vening Meinesz, *Observations* [note 141], p. 1, is equally vague. A first trial of 24 hours is mentioned in A. A. Manten, "In Memoriam F. A. Vening Meinesz," *Tectonphysics*, *3* (1966), 364-73, on p. 369.

147 The first colonial submarine, K I, was towed to the Indies in 1916; the second, K III, travelled under its own power in 1920. Von Münching, *Schepen* [note 142], p. 41; *Wegduiken* [note 142], pp. 137, 139. The submarines K II, K VII, and K VIII formed the "Pelikaan-Division" of the colonial submarine service, the name taken from their support vessel.

148 Vening Meinesz, *Observations* [note 141]; Vening Meinesz, *Gravity Expeditions at Sea, 1923-1930; vol. 1: The Expeditions, the Computations and the Results* (Delft, 1932). On the voyage of K II and Vening Meinesz, *Wegduiken* [note 142], pp. 177-8 and pp. 316-18 (Vening Meinesz's recollections). Also: "Pelikaan, K II, K VII en K VIII; overvaart naar Oost-Indië," *Jaarboek van de Koninklijke Marine 1923-1924* (The Hague, [1925]), pp. 6-25.

149 Van der Linden and Wytema, K XIII [note 142].

he appealed to the findings of descriptive geologists. He concluded in 1930 that the deviations indicated real departures from isostasy which could be of neither deep-seated nor crustal origin. Rather, they had to be explained by the downbuckling of a portion of the rigid crust due to transversal pressure from the Asian landmass in the general direction of the Pacific Ocean. The analysis came naturally to a scientist with a background in mechanical engineering. The Indonesian archipelago, following this view, was in the first stage of mountain-building, where positive ridges arose on either side of the downthrusted fold (the buried mass of which accounted for the gravitational anomalies). Vening Meinesz believed that the sea-side slopes of the Philippine and Java trenches were "a true image of the sloping of the earth's crust towards the downward fold, which is situated itself below the ridge bordering the deep on the land side."[150]

Vening Meinesz's explanation for the negative gravitational anomalies in the region of Southeast Asia required that the ocean floors have enough strength to permit folding. This circumstance and the great stresses in the crust, he emphasized in 1930, both went counter to what Alfred Wegener required of the ocean floors for continental drift. Vening Meinesz had wanted to test Wegener's theory with gravimetric data as early as 1925; then, in reporting on the K II expedition, he emphasized that continental drift would require gravitational anomalies to parallel the topography of the ocean floor, and that a sudden change in the specific gravity of the crust would have to occur at the edge of continental shelves.[151] When he passed through the Indies on the K XIII expedition in 1927, Vening Meinesz lectured in both Batavia and Bandung on how his gravimetric data, when reduced, would provide an explicit and crucial test of Wegener's theory.[152] By 1929, Vening Meinesz announced that his results spoke against Wegener's assumption of "a sucking effect behind westwardly moving islands."[153] He was not adverse to the phenomenon that Wegener described, however. He wrote in 1930:

> It is, however, another question whether the folding hypothesis is also contradictory to the principal subject of Wegener's theory, the continental drift itself. The horizontal movement of the Asiatic continent, which this hypothesis likewise assumes to occur, renders it not improbable that both principles may be reconciled.[154]

150 Vening Meinesz, "Maritime Gravity Survey in the Netherlands East Indies: Tentative Interpretation of the Provisional Results," *Amst. Proc.*, *33* (1930), 566-77, on p. 572.

151 Vening Meinesz, "The Determination of Gravity at Sea in a Submarine," *Geographical Journal*, *65* (1925), 501-21, on pp. 513-14.

152 Vening Meinesz, "Zwaartekrachtsmetingen a/b H. M. Onderzeeboot 'K XIII,' " *NT*, *87* (1927), 237-57, on pp. 248-9, 253-5.

153 Vening Meinesz, "Results of Gravity Determinations upon the Pacific and the Organisation of Further Research," *Proceedings of the Fourth Pacific Science Congress* [note 121], *2B*, 661-7, on pp. 665-6.

154 Vening Meinesz, *Amst. Proc.*, *33* (1930) [note 150], p. 576.

14. Felix Andries Vening Meinesz. Utrecht, Universiteits-Museum.

The critical problem was less the fact of crustal motion than "the nature of the forces which are supposed to act on the crust." These would be elucidated by further research in geology, vulcanology, seismology, and subterranean surveying. With the passage of time and more submarine gravimetric data, Vening Meinesz concluded that the evidence went against Wegener in the Atlantic, too, which in his view had to be under compressive crustal forces.[155]

Vening Meinesz might have modified his anti-Wegenerian inclinations following the analysis of his geologist colleague at Leiden, Berend George Escher, who remarked on the close parallel between volcanic activity and the Meinesz belts and who introduced Arthur Holmes's hypothesis of continental magma flow to account for the phenomenon. According to Holmes, heating beneath the continental masses due to radioactivity produced an outward flow of magma from below the land. In Escher's view, this could explain both the rifting of the New World from Europe and Africa and also the Indonesian gravimetric data.[156] Vening Meinesz accepted the Indonesian part of Escher's explanation but he found the Atlantic part unsatisfying.

Just as true things may be discovered by false means, observationalists may be wrong in theoretical matters for the right reasons. For Vening Meinesz continental drift seemed counter to an impressive body of data in gravimetry. The key feature of Vening Meinesz's research from the present perspective concerns his lack of collaborators in the East Indies. None of the many colonial geologists or geophysicists took up his gravimetric research program. Vening Meinesz enjoyed friendly relations with Jacob Clay, the professor of physics at the Bandung Institute of Technology; he calibrated his pendulums in Clay's laboratory and, in the the 1930s, undertook cosmic-ray observations on Clay's behalf.[157] On all his Indonesian submarine expeditions, Vening Meinesz made use of daily time signals sent out from the giant radio tower on K. A. R. Bosscha's plantation and verified by an engineer of the colonial topographical service at the Bosscha Observatory.[158] Vening Meinesz cited the work of colonial scientists, notably S. W. Visser's survey of seismic activity.[159] But the colonial scientists at the Batavia observatory each sought to make a name as an independent

155 Vening Meinesz, J. H. F. Umbgrove, Ph. H. Kuenen, *Gravity Expeditions at Sea, 1923-1932; vol. 2: Report of the Gravity Expeditions in the Atlantic of 1932 and the Interpretation of the Results* (Delft, 1934), pp. 195-6; Vening Meinesz, "The Gravity Expedition of Hr. Ms. O 13 in the Atlantic," *Amst. Proc., 35* (1932), 1143-9, on p. 1146. The published record shows Vening Meinesz to have been more deliberative about Wegener's notion of continental drift than is suggested in Laudan, "Dutch School" [note 140], pp. 661-2.

156 Escher, "On the Relation between the Volcanic Activity in the Netherlands East Indies and the Belt of Negative Gravity Anomalies Discovered by Vening Meinesz," *Amst. Proc., 36* (1933), 677-85.

157 Vening Meinesz, *Gravity Expeditions at Sea, vol. 1* [note 148], pp. 71, 77; Veldkamp, "Betekenis" [note 140], p. 56.

158 Vening Meinesz, *Gravity Measurements at Sea, vol. 1* [note 148] pp. 42, 70.

159 Vening Meinesz, *Amst. Proc., 33* (1930) [note 150], p. 575.

researcher. By the late 1920s they did not have the means to begin an archipelago-wide survey, and they would not permit themselves to be colonized by a metropolitan savant.

# 4

# Knowledge Radiant and Resplendent

## The Private Institute of Technology

With the beginning of the twentieth century, the colonial regime in the Dutch East Indies put a humanitarian face on its commercial exploitation. It began an "ethical policy," according to which the metropolis, in view of the great wealth that it had extracted from the colony, would be obliged to consider the welfare of Indonesians. As part of this new turn, Dutch-language educational institutions underwent renovations to produce a managerial and administrative elite. Over the first two decades of the century, racial separation ended in higher secondary and professional schools. Education for Indonesians became a matter of importance, for the relatively small number of colonists lacked the resources to control all facets of their colony's commerce.[1]

Colonial administrators differed about whether the ethical policy meant emphasizing elite education or mass instruction. Christiaan Snouck Hurgronje, the great Dutch scholar of Islam and from 1891 to 1906 a trusted adviser to the colonial government, favored elitism; Alexander W. F. Idenburg, between 1902 and 1919 serving three terms as minister of colonies and one term (1909-16) as governor general, favored basic and practical education for the masses.[2] Yet disagreement over aims did not compromise the steady growth of higher education. In 1898 the colonial regime expanded a "Dokter-Jawa" school at Weltevreden, which since 1875 had been running a five-year course of study to train Indonesian medical personnel, by adding a three-year preparatory department in exact sciences and languages; other modifications followed. By 1913 the result allowed Indonesian graduates desiring a Dutch medical degree to bypass all theoretical examinations in the metropolis.[3] In 1914 Dutch secondary schools opened to Europeans, Chinese, and Indonesians without discrimination.[4] University-level education came following Idenburg's replacement

1 M. C. Ricklefs, *A History of Modern Indonesia* (London, 1981), pp. 143-54.

2 *Ibid.*, p. 148.

3 Paul Christiaan Flu, *The History and Present State of Scientific Medical Research in the Dutch East Indies* (Amsterdam, [1924]), pp. 10-11.

4 Ricklefs, *Modern Indonesia* [note 1], p. 150.

as governor general by Johannes Paulus graaf van Limburg Stirum. The new governor acted only as a benign overseer in the genesis and early evolution of the *technische hoogeschool* (TH) at Bandung.[5] It is characteristic of Dutch higher learning overseas that institution-building began with private initiative.

In 1917 a group of traders, industrialists, and agriculturists in the Netherlands decided to bring higher technical learning to the East Indies. Their project received sanction as the Royal Institute for Higher Technical Education in the Netherlands Indies. They attracted the support of the principal Dutch engineering society and of the colonial ministry. By 1919 three-and-a-third million guilders had been collected. The curriculum took shape: Civil engineering would be at its center, and chemical engineering would also have a place, but pure mathematics and pure physics received much attention. According to one plan, nearly 50% more time went to the pure fields in the Indies than at the Delft TH.[6] The town councillors of Bandung knew how to welcome such an investment: They provided land for a campus. The first building of the TH was in place for inauguration ceremonies in July 1920.[7] The cement guaranteeing firm adhesion of the Dutch creation to Javan soil came from a special body, the College of Directors, which mediated between the sponsors in the Netherlands and the curators and staff in the East Indies. The president of the college, naturally enough, was Java's foremost philanthopist, Karel Albert Rudolf Bosscha. At the head of the TH directors, Bosscha—a man who had failed to receive an engineering diploma at Delft—handed out such diplomas by the score. His special attentions turned toward the exact sciences. We have seen that he was the central benefactor behind the observatory at Lembang.[8] We shall see that physics had a special place at the TH, and Bosscha was the one who endowed its laboratory.

There can be no doubt about the aims of the men who created the TH. According to Rudolf Adriaan van Sandick, a council member of the Royal Institute in the Netherlands and a prominent advocate of modern engineering education, the first step toward university-level education in the East Indies had to be taken by engineering sciences. Students at the TH were to become the "general staff" for an army of technicians. To achieve this end, he and his colleagues demanded high quality instruction, inspired by the model of Delft but informed by local circumstances.[9] Their

5 "Limburg Stirum," *BWN*, *s. v.*

6 S. Hoogewerff, C. W. Weys, and R. A. van Sandick, *Het Leerplan der op te richten Nederlandsch-Indische Technische Hoogeschool* (The Hague, 1919), pp. 22-3, tables A and B.

7 The history of the TH is taken from the remarks of Rudolf Adriaan van Sandick, appearing in the official report of the opening of the school, *De Technische Hoogeschool te Bandoeng, stichting van het Koninklijk Instituut voor hooger technisch onderwijs in Nederlandsch-Indië* (Weltevreden, 1920), pp. 3-8, on pp. 3-4.

8 See chapter two.

9 Van Sandick, in *Technische Hoogeschool te Bandoeng* [note 7], pp. 5-6. Van Sandick, during a time in the Indies, edited the influential journal *Indische Gids*. Jacques van Doorn, *The Engineers and the Colonial System: Technocratic Tendencies in the Dutch East Indies* (Rotterdam, 1982) [Comparative

desiderata are revealed in the design of the campus. The Dutch architect, Henri Maclaine Pont, began with the principle that a scientific institution would be well served by military barracks. He then created an inspired amalgam of traditional, sweeping West Javan roofs, half-timbered Tudor interiors, and rough stone colonnades.[10]

The colonial government studied the TH experiment. It watched as enrolment rose from 28 in 1920 to 92 in 1924, the year when the first diplomas and an honorary "doctorate in technical science" were awarded, and when a separate law faculty materialized. It saw the teaching staff rise from 4 to 25, the science professors publishing the results of their research just as at a university in the Netherlands. When all seemed in order, Governor General Dirk Fock integrated the two faculties into the colonial educational system and assumed responsibility for their operating expenses—some *f* 400,000 per year.[11] The second dean (*voorzitter*) of the Faculty of Technical Sciences was the physicist Jacob Clay, the only professor present at the opening of the TH in 1920.[12] His career, more than that of any other staff member, reveals a commitment by the TH to pure learning.

## The Making of a Colonial Physicist

Clay was born the son of a farmer in Berkhout, near Hoorn, in 1882. His family sent him to the Erasmiaans Gymnasium in Rotterdam, a pioneering coeducational school. From there he went, in 1900, to the University of Leiden. Eight years later he received a doctorate under Heike Kamerlingh Onnes for a dissertation on galvanic properties of metals and alloys at low temperatures, but his interests extended far beyond experimental physics

Asian Studies Programme, Erasmus University Rotterdam, Publication N° 6], p. 26. "Van Sandick," *BWN*, *s. v.*

10 The buildings are well preserved in Bandung. Many photographs appear in the *Jaarboek der Technische Hoogeschool te Bandoeng, Lustrum-Uitgave 1935* [Bandung, 1935], which also provides a capsule chronology. Maclaine Pont gives his design criteria in his *Concept-Program voor den bouw der Nederlandsch-Indische Technische Hoogeschool op Java* [The Hague, 1918?].

11 Funding in: Amsterdam, Koninklijke Akademie van Wetenschappen, *Universiteiten en hoogescholen in Nederland en Nederlandsch-Indië* (Leiden, 1930), pp. 53-102. Here are found comparative statistics on enrolment and funding, and much discussion is given over to educational philosophy. Pious pronouncements from the governor general, the university administrators, the faculty, and K. A. R. Bosscha in: Technische Hoogeschool te Bandoeng, *Overdracht der Hoogeschool aan den Lande, op 18 October 1924* [Bandung, 1924]. Jacob Clay reported the doctorate of technical science awarded to Jan Willem IJzerman in his report as dean of the faculty, *Rede uitgesproken op den vijfden verjaardag der Technische Hoogeschool te Bandoeng* (Bandung, [1925?]), p. 10. IJzerman was one of the pillars of the Royal Institute for Higher Technical Education in the Netherlands Indies. The first earned doctorate, that of Nicolaas Hendrik van Harpen, came in 1930. *Jaarboek, Lustrum-Uitgave* [note 10], p. 110; Van Harpen, *De Electrometrische Bepaling van de waterstofionenconcentratie in de latex van Hevea Brasiliensis en hare toepassing op technische vraagstukken* (Dr ing. diss., Bandung TH, 1930). The publications of the TH faculty, taken as a whole, seem to compare favorably, in quantity and in quality, with the learned production of metropolitan colleagues. *Publicaties Technische Hoogeschool Bandoeng in de periode 1920-1936*, eds P. P. Bijlaard, *et al.* (Bandung, [1936]).

12 Clay and the TH rector were the only staff present at the inauguration ceremonies, according to R. A. van Sandick in *Technische Hoogeschool te Bandung* [note 7], p. 8.

to embrace Hendrik Antoon Lorentz's theoretical work and the philosophy of neohegelian Gerardus Johannes Petrus Josephus Bolland.

Over the decade after obtaining his doctorate, Clay progressively retired from low-temperature measurements as he forged a philosophy of science based on a critique of neohegelian doctrine. From 1907 to 1920 he taught *gymnasium* in Delft, in 1912 becoming privatdocent in philosophy of science at the institute of technology there. His long essay on the the history of the concept of natural law in modern philosophy, in 1915, received a prize from the Stolpiaans Legaat in Leiden. This and shorter papers in philosophy led to a definitive break with Bolland's brand of neohegelianism in 1919 and, in 1920, to a long treatise on epistemology. When he steamed off to become the first professor of physics at the Bandung TH, he was the most prominent philosopher of science in the Netherlands.[13]

The opening years of the twentieth century saw women flooding, for the first time, into European university courses of mathematics and physics. A physics class was certainly the right place to be introduced to a suitable husband, although the reasons for the influx more likely have to do with the rise of serious secondary education for girls. In a class of nothing but girls, shining as an intellectual entailed no shame. Expectations changed when young women burning with a desire to study science found themselves channeled into coeducational schools and then surrounded by men in university lectures and laboratories.[14] Unyielding social pressures set the pattern that has remained for the rest of the century: Talented physics students married each other, and the woman came to subordinate her research or professional interests to those of her husband. Part of the story of physics in the Dutch East Indies concerns women researchers, and central among these is Jacob Clay's wife.

Tettje Clasina Jolles met Jacob Clay at Leiden, where both were physics students. She had grown up in comfortable surroundings, although later in life she subjected her filial feelings to blistering self-doubt. She wrote to her sister in 1922:

13 J. J. Boasson, "Jacob Clay," *Jaarboek van de Maatschappij der Nederlandse Letterkunde te Leiden*, 1955-56, pp. 55-8; G. W. Rathenau, "Levensbericht van Jacob Clay," *Amst. Jaarb.*, 1955-56, *s. v.*; "In Memoriam Jacob Clay," *Synthese*, *9* (1955), 423-7; E. W. Beth, "In Memoriam Jacob Clay," *Algemeen Nederlands Tijdschrift voor wijsbegeerte en psychologie*, *47* (1955), 233-5; H. F. Jongen, "The Physicist J. Clay," *Synthese*, *9* (1955), 428-32; "Claij," *BWN*, *s. v.*, also by Jongen. On coeducation at the Erasmiaans Gymnasium: J. Brok-ten Broek, "De Ontplooiing in de negentiende eeuw," in *Van Moeder op dochter: Het aandeel van de vrouw in een veranderende wereld*, eds J. Brok-ten Broek, P. M. Franken-van Driel, Clara M. Meijers, and E. A. Heringa-van Ruth (Leiden, 1948), pp. 1-192, on p. 108.

14 The coeducational ethos triumphed during the first decade of the twentieth century. In 1890, around 1400 girls attended girls' schools, while fewer than 400 attended coeducational schools. By 1911, 1800 girls attended girls' schools, while coeducational facilities drew 2400 girls. Between 1885 and 1900, girls constituted around 30% of all secondary-school pupils. Clara M. Meijers, "1898-1928: Intree in de maatschappij," in *Van Moeder op dochter* [note 13], pp. 193-372, on pp. 274-5, graphs 1 and 2.

15. Low-temperature tea at Leiden, *ca.* 1905. Willem Hendrik Keesom standing at the left, Cornelis Braak with arms folded, Tettje Jolles and Jacob Clay behind her. Courtesy of Mevr. Nelke van Osselen-Clay, Bilthoven.

> We are so disengaged from our parents. We are so self-sufficient and uninvolved emotionally. Our mother was a good person who did many things and succumbed to many difficulties. How then is it possible that I do not feel any loss when she died, and that I have not felt it one minute in these one-and-a-half years? And that the feeling not to have a mother anymore does not mean anything to me? With Papa I experience the same thing, but that is understandable; he never counted as a complete human being. But about Mama I don't understand. Do I have an icicle in place of my heart, where I should have love for my parents? When I think about my house I recognize many things my mother did but nowhere does it make my heart warm. And I am sorry for the difficult life that she had, but to want her back from the dead to make it up to her, No. Do you think that my children will do exactly the same thing, that it is God's wrath? I can't sort all this out. And sometimes I believe that perhaps the love of children for parents has been invented, and the real love between parents and children is much rarer than the real love between a man and wife.[15]

These are normal doubts, although they do suggest the attraction exerted

15 BOC. Tettje Clay-Jolles to Hesje Jolles, 26 Feb 1922.

on Tettje by scientific certainty. It is possible that initially, at Leiden, she studied both medicine and physics. "Prof. Korteweg is terrific," she wrote to her sister in 1903. "It is amazing what he knows." When she was not attending lectures, she went to the physics laboratory where Cornelis Braak supervised the beginning students.[16] The exact sciences quickly won her allegiance. "This afternoon in the laboratory we had to resist the temptation not to leave work and go out in the beautiful weather," she wrote to her sister early in 1904.

> It is so good here in the lab for one's character, to learn patience. This afternoon a leak was discovered in one of my test tubes (not even my fault) which renders all my work from after Christmas completely useless, and it has to be redone now. But it was good for my own experience.[17]

Among the women physics students, Tettje was the most devoted to her discipline. When the donation of a set of teacups to the students' physics club by Kamerlingh Onnes's wife permitted afternoon tea, Tettje did what was required: "For the moment I am doing the honors, as I am the only girl."[18] By 1905 she and Jacob Clay, who was a fifth-year student, had become engaged.[19] From then on, Tettje's love for physics progressively sublimated into her love for her future husband. To her sister again:

> I do not know yet whether I will finish a doctorate, but I am more inclined to do one now. Jaap thinks that this dr title will help me get a side-line job, and that is perhaps good. I'll be glad when I do not have any more exams. Then I won't feel guilty about all the evenings that I did not work.[20]

Jacob Clay received an appointment at the Delft *gymnasium* during the summer of 1907. The couple lived separately for another year while each continued work on a doctorate. Jacob defended his dissertation in June 1908. The next month he and Tettje became man and wife. Tettje persisted at her own research for six more months. She wrote to her sister in December 1908:

> Yesterday my instrument broke (not the fault of me or anyone else), so that it will take another several weeks to get as far as I

16 BOC. Tettje Jolles to Hesje Jolles, 9 Nov 1903. The only Leiden professor with surname Korteweg at this time was Johannes Adrianus Korteweg, a surgeon. The reference may be to a lecture by the Amsterdam mathematician Diederik Johannes Korteweg. "Korteweg," *DSB*, *s. v.*

17 BOC. Tettje Jolles to Hesje Jolles, 19 Feb 1904.

18 BOC. Tettje Jolles to the Jolles family, 1904. By 1900/01, 64 women were registered in Dutch science faculties. Magrita J. Freie, "In Opvoeding en onderwijs," in *Vrouwen van Nederland 1898-1948*, ed. M. G. Schenk (Amsterdam, 1948), pp. 89-107, on p. 102.

19 BOC. Tettje Jolles to her parents, 29 Sep 1905.

20 BOC. Tettje Jolles to Hesje Jolles, 21 Jan 1907.

> was. And that I would have to work on for a long time after Christmas. Now I have given up on it. . . . And I will write a letter to Onnes, that I am stopping with it.[21]

Though Tettje's talents turned toward raising her children, she kept her hand in physics. She served as her husband's laboratory assistant in the East Indies. As we have seen in chapter three, she authored or coauthored a number of original scientific papers. In 1921 she edited a volume of Lorentz's lectures on thermodynamics.[22]

With his domestic situation placed in the best of hands, and with only fifteen hours of classroom instruction required for his *f* 2000 annual salary, Jacob Clay forged ahead in both physics and philosophy. At first he hoped to work in the laboratory of the professor of physics at the Delft TH, Lodewijk Hendrik Siertsema, but in 1909 Kamerlingh Onnes asked him to return to Leiden where he would be able to carry out his own research and also supervise students. The pay was *f* 3 per afternoon, "not a bad wage," as Tettje noted, and Clay accepted.[23] Over the next several years Clay published a series of experimental results on low-temperature physics. He continued studying neohegelian philosophy of science, a direction he enlarged on as privatdocent at the Delft TH. By 1920 philosophy had come to dominate his intellectual interests.

Clay's early vision of science is revealed in his inaugural lecture at Delft on the philosophy of science, which bore the title, "the three-fold nature of natural knowledge." All science, when dissected, contained three elements: observation, ideas, and understanding. Observation was the connection of separate experiences, which could not be made, however, without logical apparatus. On this point Clay posited that peoples like Kaffirs and Papuans, "whose brains are not developed logically," were unable to have scientific experiences, and he used the occasion to signal a "contradiction in terms" regarding Max Planck's belief in the profound cleavage between reversible and irreversible processes in physics, on the one hand, and his just as firm belief in the objective reality of the perceived world, on the other hand. As far as ideas went, they occurred randomly. Ideas were the mental representations of pure facts—the perfectly elastic body, the ideal gas, the magnetic pole—as these facts could not appear in nature; ideas

21 BOC. Tettje Clay-Jolles to Hesje Jolles, 10 Dec 1908. The first woman to receive a doctorate in physics from a Dutch university was H. B. van Bilderbeek-van Meurs, in 1909 under Pieter Zeeman at Amsterdam. W. Minis-van de Geijn, "Wetenschappelijk Werk op exact terrein," in *Vrouwen van Nederland* [note 18], pp. 262-71, on p. 268.

22 In addition to the publications cited in chapter three: Tettje C. Clay-Jolles, "Moderne Vacuumpompen," *3° NINC Hand.* (1924), pp. 218-9; H. A. Lorentz, *Lessen over theoretische natuurkunde, 4: Thermodynamica*, ed. T. C. Clay-Jolles (Leiden, 1921). Lorentz exercised care in choosing the editors of at least some of his earlier volumes: A. D. Fokker edited the volume on radiation theory, G. L. de Haas-Lorentz that on quantum theory, and H. Bremekamp that on ether theories and models.

23 BOC. Tettje Jolles to Hesje Jolles, 28 Aug 1907, for salary at the Delft *gymnasium*. Tettje Clay-Jolles to Hesje Jolles, spring 1909, for Kamerlingh Onnes's call.

presented nature as "an orderly, perhaps aesthetic unity." Ideas—in the "pure and well-organized thought process of every individual"—also depended on the logical process of knowledge; this was, in Clay's view, Hegel's profound insight.

The three elements of science lay at the base of a self-reflexive process. One could begin by experiencing phenomena, pass to formulating ideas or hypotheses about the phenomena, go from these idealized facts to make observations on carefully chosen experiments, and then graduate to the logical generalization of the ideal facts—that which is called the theory and its laws. The process of scientific understanding became circular when the theory returned to seek verifying proof of the raw phenomena. To illustrate how each of the three elements depended on the whole, Clay gave the example of his three professors, Kamerlingh Onnes, Lorentz, and Bolland. Kamerlingh Onnes was the man of action, an observer who worked precisely with measuring machines; Lorentz was the genius who designed profound new theories; Bolland was the deep logician invested with a great store of positive knowledge.[24]

Bolland stood at the head of this holy trinity. Clay was one among many students who fell under his spell. An early philosophical essay, in fact, reprimanded the professor of psychiatry at Leiden, Gerbrandus Jelgersma, who had dared warn students about Bolland's "intellectual impurity."[25] Master did not hesitate to chide disciple when Clay left Leiden for Delft without publically stating how Bolland's teachings had "been advantageous or influenced" his intellectual development. "I deem your negligence of this a large Nicodemian mistake," Bolland wrote to Clay, "which will later on cause you much grief, a mistake that can't be talked right, even though I personally will take your counsel as half a justification." Bolland emphasized that the matter would remain bothersome to him, although "I can't say that I bear a grudge."[26] There is every reason to think that Bolland was serious in his warning.

Clay spent much of the next decade working his way through Bolland's neohegelianism.[27] As he introduced increasingly more material from modern physics into Bollandism, however, the master's synthesis grew obscure; its parts creaked and groaned under the weight of scientific evidence. As he grew disenchanted with the claims of immanent reason, Clay felt the breeze of neopositivism. The wind broke Bolland's hold.[28] By this time, as

24 Clay, *De Drieledigheid der natuurkennis* (Haarlem, 1912). Extracts from pp. 5, 18, 21, 23-4, 29-30.

25 Clay, "Prof. Jelgersma contra Prof. Bolland," *Minerva, 31* (27 Sep 1906). Beth, "In Memoriam" [note 13], dates Clay's first philosophical publication in 1907.

26 LMB, Arch. 234 C. Bolland to Clay, 9 Oct 1908.

27 Clay's philosophy of science, and especially his relationship to Bolland, is elaborated in Klaas van Berkel, "Wetenschap en wijsbegeerte in het werk van Jacob Clay (1882-1955)," in *Filosofie in Nederland: De Internationale School voor Wijsbegeerte als ontmoetingsplaats 1916-1986*, eds A. F. Heijerman and M. J. van den Hoven (Amsterdam, 1986), pp. 65-92.

28 Clay, *De Dialektiek en de leer van de tegenstrijdigheid bij Hegel en Bolland* (Sandpoort-

Clay knew, Bolland found few supporters among physicists on the leading edge of research. Bolland came up in conversation when Albert Einstein visited Leiden in 1920, physicist Adriaan Daniel Fokker wrote to Clay. According to Fokker, Einstein was arguing that the ether and the material body both enjoyed the same kind of existence.

> The intention is, that which made the free particles follow geodetical lines is just as real as the particles themselves. The word 'Existenz' is ugly here. Philosophically speaking it is doubtful whether a body exists. I remarked confidentially to [physicist Paul] Ehrenfest that he should have said 'validity,' whereupon Ehrenfest cried 'Bolland!' to which I had to agree. Then he said across the table, jokingly, that Einstein should take lessons from Bolland. Lorentz, who did not understand what Bolland had to do with it, said, 'That is not necessary at all. Bolland can learn much from Einstein, and not vice-versa.'[29]

In his philosophical commentaries during the late 1910s, Clay argued precisely for Lorentz's point of view.

The curators at Bandung evidentally sought a physicist who—no rude technologist—would serve to propagate the values of Dutch learning. Among technologically or philosophically apprised physicists, none in the Netherlands had expressed more interest in pedagogical questions than Jacob Clay. In 1916, he became an adviser to the circle of educators who advocated an International School for Philosophy in Amersfoort and eventually contructed an experimental institution there.[30] The essayist, art critic, and painter Just Havelaar, one of his friends in the Amersfoort project, received news of Clay's call to Bandung with mixed feelings: "The Indies need people like you," Havelaar wrote in 1919, but "Holland, too, needs people like you, desperately."[31]

With respect to pedagogy, Clay performed as expected in his first publications at Bandung. In a festschrift for the opening of a classical *gymnasium* in Bandung, Clay reviewed ancient Greek philosophy and warmly greeted "the new project for secondary education in classics." He lauded the emphasis by the colonial departement of education on ancient Greek language and culture. Clay restated the battle-cry of early nineteenth-century German neohumanists. What happened in Greece two thousand years ago constituted "the greatest wonder known to the history of mankind." Greek antiquity saw the beginning of the development of Western art, science, philosophy, and religion. No one, in the colonies or in the

Bloemendaal, [1919]), published as *Handelingen van het Genootschap voor Zuivere Rede, 1917-1919, 1° Gedeelte* and based on a lecture to the society in June 1919. He dealt with his critics in a pamphlet, *Geloovig hegelianisme* (Bloemendaal, [1920]), published in March 1920.

29 LMB. Fokker to Clay, 12 Dec 1920.

30 LMB, Arch. 234 C. Amersfoort, Internationale School voor Wijsbegeerte, announcement of 20 Mar 1916.

31 *Ibid.* Havelaar to Clay, 6 May 1919.

metropolis, could truly be educated without having had intercourse with the great minds of ancient Greece:

> Familiarity with this old source of human greatness is essential not only for European children, but also for the best of Indian youth. It is an especially excellent way for the latter to be raised up to higher civilization. It is not enough for us Dutch to bring only technology here. It would be false for the Indians to think that technical development is the characteristic of European civilization. In modern times that may seem so by the rapid revival [*opbloei*] of technology, but next to it and above it is the development of the humanities. For the development of the Indian people we must not forget to place this to the fore, more than has been done up to now.[32]

Here was a twentieth-century man who knew how to sing the nineteenth-century neohumanist score.[33] Here was a scientist at an institute of technology who valued classics as an essential, civilizing force.

By 1922 Clay had distinguished himself as a major voice in education and philosophy. His manifest talents led the Faculty of Letters at Leiden to name him as their first choice, in 1922, to succeed his old mentor Bolland; Clay's position at Bandung may even have made him a privileged candidate, for Bolland had taught school at Batavia before winning his way to Leiden.[34] Clay's salary was to be *f* 7500, which would rise after several years to *f* 9000.[35] In their recommendation to the educational authorities in The Hague, however, the university curators reversed the order of preference of the faculty, and a theologically-inclined philosopher from Groningen, Arthur Joseph de Sopper, inherited Bolland's mantle. Clay and his wife were not unhappy to remain at Bandung. As Fokker (who had come into Clay's *gymnasium* position, house, and servants in Delft and then became professor at the institute of technology there) wrote to Clay a year later:

> I received the impression from your last letter that you are happy in Bandung (maybe happier than you would have been or be in Leiden?). I believe then that no one has suffered because of the decision of the Leiden curators to change the

32 *Zeven Artikelen over Grieksche kultuur* (Bandung, 1923), with Clay's contributions: "Het Nieuwe Ontwerp voor het middelbaar onderwijs en de klassieke opleiding," pp. 6-14; "Grieksche Philosophie," pp. 81-9. The latter article was abstracted in the local newspaper, *Preangerbode* (24 Feb 1923). Quotations from "Nieuwe Ontwerp," pp. 5, 10-11.

33 Lewis Pyenson, *Neohumanism and the Persistence of Pure Mathematics in Wilhelmian Germany* (Philadelphia, 1983) [American Philosophical Society, *Memoirs, 150*].

34 E. H. Kossmann, *The Low Countries, 1780-1940* (Oxford, 1978), p. 425, for Bolland's colonial years.

35 LMB, Arch. 234 C. Secretary of the Faculty of Letters and Philosophy (G. J. Thierry) to Clay, 11 May 1922.

> order of recommendation of the faculty and place De Sopper as #1?[36]

Clay may well have been simply too broadly inclined and too modernist for the Leiden curators. Friend and foe saw him as an essential civilizer in the East Indies. Philosopher Johannes Diderik Bierens de Haan, one of Clay's friends at the Amersfoort school, wrote in 1922 after the Leiden appointment fell through:

> With interest I read your speech on nature and civilization and joyfully saw that even if technical education is the real task of the institute, that it also is concerned with philosophy, and that it is moving toward a higher plane than that of merely obtaining practical results. It appeared from your speech that you are the right man for the position you occupy, and you should not regret that the chair in Leiden is taken by another professor.[37]

Fokker, too, put the best face on Clay's rejection. He reported the comment of a disappointed Leiden medical professor to the effect that Clay at Leiden "would be like a race horse in a stable."[38]

## The Tropical Institute of Pure Physics

Clay received the news from Leiden with mixed feelings because he had just inaugurated a new physics laboratory, and his wife Tettje had gone on the payroll as an assistant. Tettje explained their quandry in a letter to her sister:

> Now a very important subject. Maybe you know it already and it is already known in Holland. If not, then please don't mention it. But, Jaap has been contacted by telegram to become Bolland's successor, i.e., the faculty wants to place him first on the list. We are getting fourteen days to think about it. And we have fretted and brooded about it, discussed the advantages and disadvantages. Finally, yesterday, we sent a telegram that we are doing it if Jaap will be appointed, which is not certain, of course. We also asked for travel allowance, etc. It is possible that they do not want to pay for this anymore in this frugal time. But all in all, there is a large possibility that it will happen, and then we will be back in Holland again. It won't happen quickly, because, first, Jaap's appointment can take time, and, also, we will not leave before there is a successor for Jaap here. We actually have a contract here for 5 years. It is possible, too, that

36 LMB, "Fokker." Fokker to Clay, 4 Mar 1923, penned postscript to a typed letter. Fokker describes the terms of his appointment as Clay's successor in a letter to Clay of 12 Dec 1920.

37 LMB, Arch 234 C. Bierens de Haan to Clay, 6 Jul 1922.

38 LMB. Fokker to Clay, 4 Mar 1923, reporting a remark by Mark Jansen.

> they will not let us go. This young institution cannot be left temporarily without physics, while Leiden can do without philosophy. It would not surprise me if it all took a year or so, and we would not regret that.
>
> It is actually true that we would not like to leave here. Jaap can separate himself from his new lab only with great difficulty, and all in all we have had such a pleasant time here that we would rather stay for another 4 years. Bolland has died an untimely death, as far as we are concerned. But, on the other hand, philosophy is more the love of Jaap's life, and such an offer will probably never be repeated, and also we do not want to stay forever in the Indies. So we went along with it, but every month that we can stay here longer we consider time won.[39]

The new laboratory, funded by Bosscha, was much more than an exercise-room for training apprentices and low-level functionaries, although one part of it served that end. It cost some *f* 300,000, not counting equipment; it came with an instrument maker and glass-blower. Ceremonies at the laboratory's inauguration provide a gauge of aims and intentions. The governor general, whose interest lay in producing technicians for the colony, expressed confidence that the installation would contribute to the "highest ends of science and efficiency [*wetenschappelijkheid en doelmatigheid*]." There was no hint in his remarks that he expected new results of practical value to issue from Clay's building. Bosscha, the principal philanthropist, considered the laboratory "indispensable for the studies of future engineers," and no expense had been spared in its construction. A school for training glass-blowers and machinists occupied one wing of the laboratory complex, but activity in the laboratory proper would be determined by its director, Jacob Clay. Assistance came from talented support staff as well as Clay's physicist wife, but Bosscha remained silent about the nature of the director's tasks.

Clay's discourse at the opening of his laboratory concerned science and civilization (it was the one discussed by Bierens de Haan). He explained that physics transcended practical problems. An experiment "is a fruit of intellectual civilization." His experimental laboratory would be devoted to research, for physical research provided a fine illustration of the interaction between theory and experiment. Science was universal, unlike art and religion. Pure science, then, could be a civilizing force. He intoned, to loud and long applause: "The results of pure thought are the same everywhere. Nothing can further the unity of humanity more than the search for truth." In his organization of the laboratory, he said, he had benefitted from the tutelage of Kamerlingh Onnes at Leiden, and the practical side of his operation mirrored the Leidsche Instrumentmakers-

39 BOC. Tettje Clay-Jolles to Hesje Jolles, 12 Apr 1922. In 1922 Tettje received *f* 300 per month and Jacob (beginning in July) *f* 1400 per month. "It is absurd that you cannot live [here] on *f* 1200 per month with a family." Tettje Clay-Jolles to Hesje Jolles, 26 Feb 1922.

school that his former professor had set up in the workshops of the Leiden physics laboratory. Practicality, however, did not form the centerpiece of his thoughts. To students of his in the audience he issued a challenge:

> And should fortune grant you imagination or intuition—for this is a gift of nature—then it is my charge that you cultivate the gift with exactness and perseverance, so that by the results of your work you return what is here given to you.

The sense of the charge is unambiguous. No rude mechanics, students had to search for new knowledge.[40]

Clay might have used his magnificent laboratory to apprise Indonesian engineering students of Newton's laws, but both the TH curators and Clay himself wanted to range farther. The question, however, remained: What was Clay, who had been away from physical research for nearly a decade, to do at Bandung? Before steaming off to the Indies, he spent some time in England with Ernest Rutherford, where he studied about radioactivity and atomic weights.[41] He came to use the source of radiation then attracting researchers everywhere who could not afford a laboratory emitter—the atmosphere.

Beginning in 1921 he sent up high-altitude balloons in an attempt to measure atmospheric electricity, which had been studied by scientists in the East Indies for a generation.[42] Clay focused on a phenomenon observed by researchers around 1900 and definitely isolated as penetrating radiation (later known as "cosmic rays") by Viktor Hess in 1912. Clay could not get his balloon electrometers to function adequately, but he persisted.[43] Around 1925 he published a detailed program for tackling electrical phenomena in the atmosphere, which gave a prominent place to the study of cosmic rays.[44] He took measurements in a deserted hydraulic

40 Bandung, Technische Hoogeschool, *Opening van het natuurkundig laboratorium, door Zijne Excellentie den Gouverneur-Generaal van Nederlandsch-Indië, 18 maart 1922* [Bandung, 1922], with addresses by the governor general, Bosscha, and Clay ("Natuurwetenschap en kultuur"), photographs, and diagrams; "De Opening van het natuurkundig laboratorium der Technische Hoogeschool," *Preangerbode*, 18 Mar 1922, which largely reproduces Bosscha's and Clay's addresses. Funding figures from Bosscha's inaugural speech. Kamerlingh Onnes's school for instrument makers is mentioned in *DSB*, *s. v.* The inspiration of Kamerlingh Onnes is recorded in *Jaarboek, Lustrum-Uitgave* [note 10], p. 33.

41 Jongen, "Clay," *Synthesis* [note 13], pp. 428-9.

42 For the deep background: E. Engelenburg, *Aerodynamische Theorie der Gewitter* (Hamburg, 1896), reprinted from *Archiv der deutschen Seewarte, 19* (1896). German debate about "durchdringenden Strahlung" in: *Protokolle der Sitzungen der luftelektrischen Kommission der kartellierten Deutschen Akademien zu Göttingen am 2. und 3. Juni 1911* (Göttingen, 1911). Also: H. R. Woltjer, "De Ontwikkeling der natuurkunde in Indonesië gedurende de 100-jarige werkzaamheid der Koninklijke Natuurkundige Vereeniging," in *Eeuw*, pp. 32-40.

43 Clay mentions the 1921 attempts in his article, "Kosmische Ultrastraling," *De Ingenieur in Nederlandsch-Indië, 1* (1934), N° 5, 1-8, on p. 2. He seems to have published his first reports in "Electrische Verschijnselen in de atmosfeer," in *3° NINC Hand.* (1924), pp. 199-206.

44 Clay, "Electrische Verschijnselen in de atmosfeer," *Amst. Versl., 28* (1925), 531-5; also in *3° NINC Hand.* [note 43]. Clay restates his program in "Atmospheric Electricity: Records and

station under 83 meters of rock; there he observed the part of the radiation present at sea level.[45] He published more high-altitude results in 1926.[46] In 1927 the years of patiently perfecting his measuring techniques paid off. Returning to the Netherlands on leave, Clay measured cosmic rays at various points during the voyage. He concluded that the intensity of the radiation depended on latitude.[47]

Clay's skills at organizing pure scientific research in Bandung received wide and favorable attention in the Netherlands. So when Remmelt Sissingh's chair of experimental physics at the University of Amsterdam fell vacant late in 1928, Clay found himself in the running for it. Around early December 1928, the second Amsterdam professor of physics, Pieter Zeeman, sent him a telegram and spoke with him by transoceanic telephone. Then he received a letter from Antonie Pannekoek, the Amsterdam astronomer who had spent time on Java in connection with the solar eclipse expedition of 1925-26.

Pannekoek explained the controversial nature of Sissingh's succession. First the Faculty of Mathematical and Natural Sciences waited to see whether the professor of thermodynamics and pedagogy Philipp Kohnstamm would resign his thermodynamical chair (which he did). Then Sissingh's position was offered to Dirk Coster, the professor of physics at Groningen. Coster, who had just received authorization to renovate his laboratory, declined. The position next went out to Herman Carel Burger, a former student of Leonard Salomon Ornstein's at Utrecht who, ten years after graduating, still lacked a university affiliation. Burger demanded as a condition that he not have to give introductory lectures to philosophy and medical students. He misjudged the reaction of the faculty, who finally decided that they did not want introductory material "left to second-rate people," as would have been required in Burger's plan. The faculty had their short list vetted. "In nearly all the letters, [Frits] Zernike [professor of theoretical physics] at Groningen was called the most talented of those mentioned and the one who meant most scientifically." Another candidate, Jan Burgers from the Delft Institute of Technology, received Pannekoek's support, although the faculty doubted if he had the experience to undertake the adminstration of a laboratory.

> The majority stipulated as first prerequisite that the entering man would have to be someone who could reorganize the

Measurements at the Bosscha Laboratory of Physics of the Technical University of Bandoeng (Java)," in National Research Council of Japan, *Proceedings of the Third Pan-Pacific Science Congress, Tokyo, October 30th - November 11th, 1926* (Tokyo, 1928), *2*, 1361-4.

45 Clay, "Kosmische Ultrastraling" [note 43], p. 2.

46 Clay, "Registratie van electrische geleidbaarheid en ionengehalte van de atmosfeer," *4° NINC Hand.* (1926), pp. 128-32.

47 "Doordringende Straling," *Amst. Versl.*, *36* (1927), 1265-77; *37* (1928), 976-83. The reports also appeared in English translation in *Amst. Proc.* Clay's cosmic-ray research is indicated in J. Veldkamp, *History of Geophysical Research in the Netherlands and Its Former Overseas Territories* (Amsterdam, 1984), pp. 27-9.

> propaedeutic teaching and the laboratory exercises and all the work of the laboratory. That's why they have named you first to the curators. Because the curators had enough of people rejecting their offers, they wanted to know beforehand whether you would do it, and so Zeeman called you. After that, the recommendation went to the curators.

The situation, however, remained complicated. The University of Amsterdam was a municipal institution, and so all appointments came at the pleasure of the B & W (*burgemeester en wethouders*, or mayor and town council). In the 1920s, the B & W were stoutly socialist, to which fact Pannekoek, as a long-time left-wing politician, owed his own appointment. Zernike had taken his doctorate at Amsterdam in 1915 and was the "son of an eminent principal popular here in all democratic circles"; he accordingly had many friends among the B & W. Pannekoek thought that the council might name Zernike over the recommendation of Clay by the curators—a replay of Clay's experience at Leiden in 1922. The byzantine world of Dutch academia presented other possibilities. Pannekoek learned that Willem Hendrik Keesom, one of the two professors of experimental physics at Leiden, had written

> to a Catholic council member to recommend his coreligionist, [Antonius Mathias Johannes Friedrick] Michels (Michels was pushed by Kohnstamm and [Michels's dissertation advisor at Amsterdam, Johannes Diderik] van der Waals [Jr] to become professor). But the faculty refused (some remembered him as a very average student). They recommended him as a *lector* for thermodynamics. The curators, in their parsimony, want to suggest him as assistant and *lector*, and give him part of Sissingh's work. So the R. K. [Catholic] members will fight hard for Michels. The mayor (A. R.) [Anti-Revolutionary Party] already asked whether [Herman Robert] Woltjer would not be good as a candidate. So this appointment will become a political party and religious battle in the council (behind closed doors), and nobody can tell what the result finally will be.[48]

Over the next months, the terms of the intrigues became clearer. Wander Johannes de Haas, the second professor of experimental physics at Leiden, advised Clay to accept a call, if it came, without making any conditions, as Burger's "crazy demands" had soured the curators about negotiations with a prospective candidate. According to De Haas, when Coster refused the first call to Amsterdam, he nominated Zernike "to get rid of him." Ornstein at Utrecht had recommended Burger, and the majority of the curators went along with the proposition. Again according to De Haas, J. Dorsche, Woltjer, Fokker, and the theoretician at Leiden Paul Ehrenfest directed

48 LMB, "Pannekoek." Pannekoek to Clay, 9 Dec 1928. Michels, *Het Nauwkeurig Meten van isothermen* (diss., Univ. Amsterdam, 1924).

attention to Clay. De Haas felt that Zernike was the only serious threat, and he did his best to discredit the future Nobel laureate: "My positive role in this is that I, as far as this was possible, wrung Zernike's neck." While Utrecht and Groningen fought for Zernike, Leiden pushed Clay. "So now you know the main things," De Haas confided. If Clay received the offer, he was well advised to "take it, because such a chance will not come easily to you again. At the next opening, they will probably come up with the argument that you are too old. And you never know when a young star will be born."[49]

Clay's old friend Fokker, who had by then advanced from a professorship at Delft to become curator of the Teyler's Stichting in Haarlem, explained more about Michels. The mathematicians at Amsterdam, led by the intuitionist Luitzen Egbertus Jan Brouwer, retained "unpleasant memories" about Michels's mathematics examination. Kohnstamm, however, "had nothing but praise" for Michels's work on high pressures, which received financial support from English industrial circles. Michels was self-assured and persistent. Fokker advised Clay to draw clear lines in the laboratory between his and Michels's territory, if they both obtained posts at Amsterdam.[50]

Pieter Zeeman reassured his intended colleague. Zeeman indicated that the curators ranked Woltjer second on their list. Zernike was frozen out. Clay would receive *f* 8000 per year over three years for instruments, plus a subsidy of *f* 4000. His salary would be *f* 10,000 yearly, with possible allowances for retirement benefits.[51] As the months dragged on to the crucial vote, Van der Waals wrote to persuade Clay of his good faith. Van der Waals worried about a public plea in favor of Zernicke by Utrecht and Groningen physicists. "It bothers Zeeman and me." Van der Waals thought that Zernike's supporters were running Michels as a Trojan horse, "to cover up their actions."[52]

The politicking took an extraordinary amount of time, as academic, political, and religious issues entered and left the debate. Six months after he had first been contacted by Zeeman, Clay received a call to the Amsterdam chair. He garnered 23 votes, compared to 13 obtained by the runner-up Zernike, who had not been on the faculty's list.[53] Michels entered as *lector* of thermodynamics and medical propaedeutics.[54] The postscript to the election came from Kamerlingh Onnes's widow, who wrote to congratulate Clay: "It was such a terrible matter, and I am distraught at the not so sympathetic people who wanted to make the

49 LMB. De Haas to Clay, 5 Jan 1929.

50 LMB. Fokker to Clay, 28 Jan 1929.

51 LMB. Zeeman to Clay, 14 Feb 1929.

52 LMB. Van der Waals to Clay, 23 Mar 1929.

53 According to notes in LMB, Arch 234 D.

54 Michels lost no time in giving his inaugural lecture as *lector* on 30 May 1929. Michels, "De Ontwikkeling der warmteleer door middel van hooge drukken," *Physica*, *9* (1929), 223-34. Michels's position is given in *Min.*, 1930, *s. v.*

appointment their business." She looked forward to seeing the Clays, whose two oldest children were then studying in the Netherlands. Maria Adriana Wilhelmina Elisabeth Kamerlingh Onnes-Bijleveld was especially fond of the Clays' daughter Nelke, a visitor of hers.[55]

## The Latitude of Scientific Priority

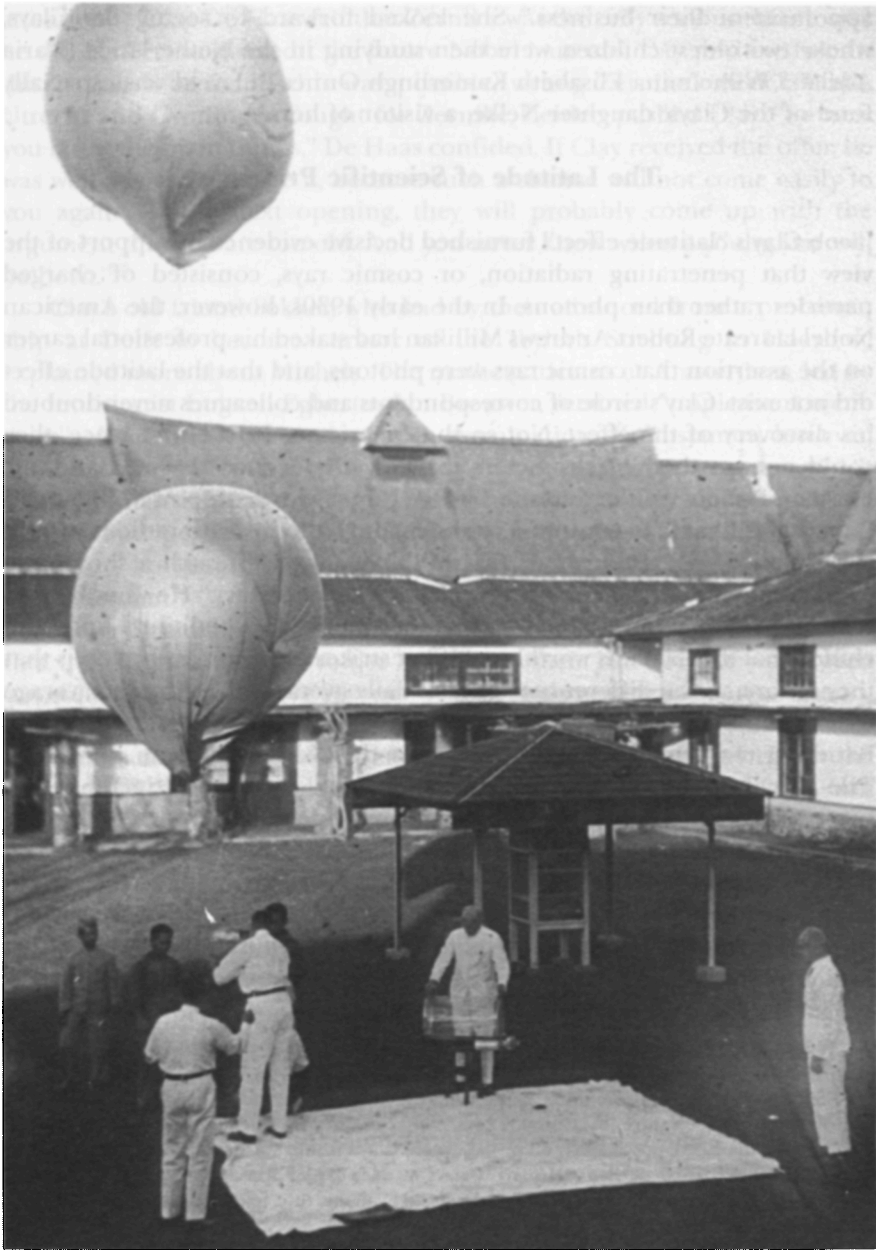
Jacob Clay's "latitude effect" furnished decisive evidence in support of the view that penetrating radiation, or cosmic rays, consisted of charged particles rather than photons. In the early 1930s, however, the American Nobel-laureate Robert Andrews Millikan had staked his professional career on the assertion that cosmic rays were photons, and that the latitude effect did not exist. Clay's circle of correspondents and colleagues never doubted his discovery of the effect. Not so the Americans. In the first place, they could not get their electrometers to work. Clay's successor at Bandung, Herman Robert Woltjer, reported in 1931 on a whistle-stop of Millikan's in Batavia. Millikan had equipped counters and balloons with radio transmitters. Woltjer was "astonished" that Millikan stayed for such a short time "and did not even deem one control launching necessary." He went back to read Millikan's reports about his South-American expeditions and concluded that the data was worthless. "What strikes me again and again is that they ignore all the differences between daily averages (I mean, the average over 24 hours)."[56] Perceptions evident at a major center of learning like Bandung took time to become clear on the North-American periphery. The heavily bankrolled Americans undertook a series of incompetent surveys of cosmic rays in distant geographical parts. Around 1932 Arthur Holly Compton at the University of Chicago confirmed Clay's observations, but he resisted the temptation to congratulate Clay for his experimental acumen.[57] Millikan, his view of physics fast shrinking to the dimensions of a nutshell, refused to abandon his prejudices, even after his student and collaborator Henry Victor Neher reported on the effect in 1933.[58]

55 LMB. Kamerlingh Onnes-Bijleveld to Clay, 5 Jun 1929.

56 LMB. Woltjer to Clay, 7 Oct 1931.

57 An example of Compton's extraordinarily ungenerous spirit may be found in his contribution, "The Nature of Cosmic Rays," in *The Science of Radiology*, ed. Otto Glasser (Springfield, Ill., 1933), pp. 398-411, on p. 404, where Clay's results for the latitude effect near the equator are held to be dubious. He is referred to as "Clay of Amsterdam." In contrast, the observations of a horde of American observers, listed by name, title, and institution, are subjected to no scrutiny whatever.

58 "Millikan," *DSB*, *s. v.* Daniel J. Kevles, "Robert A. Millikan," *Scientific American, 240*, N° 1 (1979), 118-25, on pp. 121-2; Kevles's *Physicists: The History of a Scientific Community in Modern America* (New York, 1977), does not refer to Clay although much space is devoted to Millikan and cosmic rays. In the recent collection edited by Yataro Sekido and Harry Elliot, *Early History of Cosmic Ray Studies: Personal Reminiscences with Old Photographs* (Dordrecht, 1985), Clay's research is mentioned only in passing or not at all; the retrospective accounts by Neher and Anderson are silent about Clay. Neither does Clay figure in the treatment by Qiaozhen Yu and Laurie M. Brown, "The Early History of Cosmic Ray Research," *American Journal of Physics*, *55* (1987), 23-33, which takes the story



16. Jacob Clay (at center) launching balloons with electrometer, barometer, and thermometer at the Bandung TH, 1933-34. The balloons went as high as 30 km. The instruments returned to earth by parachute after having had their readings recorded on photographic film. A description in *HD*, *43* (1945), 21. Courtesy of Mevr. Nelke van Osselen-Clay, Bilthoven.

Clay continued his careful measurements of cosmic rays until the end of his long career. The Americans and others in their orbit systematically ignored his work. As Viktor Hess informed Clay with astonishment in 1933, Georges Lemaître and Manuel Sandoval Vallarta attributed the latitude effect to Compton and Werner Heisenberg![59] Around 1935 Compton changed his mind and came to see his Dutch rival as a prophet. He sought the Nobel prize for Clay, whom he thought shabbily treated by Millikan; he proposed the "initial award to Hess and Clay for the discovery of the rays and the experimental proof that they are extra-terrestrial rays of great energy," and also to Millikan's protégé, Carl David Anderson for his use of the rays to discover the positron.[60] The 1936 physics prize went to Anderson and Hess, in that order. Hess no doubt felt himself lucky, for he had confided to Clay in January of that year: "Millikan is trying his best to make my work appear as insignificant as possible."[61]

It was usual, in the early decades of the twentieth century, for scientists to announce their discoveries in newspaper articles or interviews with reporters. Robert Millikan certainly sensationalized his research for scientific illiterates in this way, just as, in the Netherlands, Jacob Clay defended his accomplishments and priority of discovery. "The Corpuscular Nature of Cosmic Rays," announced a Saturday story of 1933 in the *Algemeen Handelsblad* which featured Clay's portrait. Without referring to Millikan, the article described the conclusive data taken by Clay and Hendrik Petrus Berlage during Clay's recent research trip to Indonesia.[62] Early in 1934 *De Telegraaf* ran features on Clay's verification of his theory of cosmic rays, and on the appearance of definitive evidence against Millikan's views.[63] The

up though 1927. The Clay-Compton-Millikan controversy is considered in Robert H. Kargon, *The Rise of Robert Millikan: Portrait of a Life in American Science* (Ithaca, 1982), pp. 158-61. Some writers, like L. Jánossy, refused to credit Clay with the latitude effect; others, like Donald Joseph Montgomery and W. F. G. Swann, gave credit where it was due: Jánossy, *Cosmic Rays* (Oxford, 1948), pp. 23-4: Montgomery, *Cosmic Ray Physics* (Princeton, 1949), p. 5; Swann, "The History of Cosmic Rays," *American Journal of Physics*, *29* (1961), 811-16, on p. 812. A devastating indictment of Millikan's reluctance to cite his intellectual forebears, and generally an indictment of his observational incompetence, appears in: K. Bergwitz, V. F. Hess, W. Kolhörster, and E. Schweidler, "Feststellungen zur Geschichte der Entdeckung und Erforschung der kosmischen Höhenstrahlung (Ultragammastrahlung)," *Physikalische Zeitschrift*, *29* (1928), 705-7, which, however, does not refer to Clay's work.

59 LMB, Arch. 117. Hess to Clay, 16 Jan 1933 and 19 Jun 1933. Lemaître and Sandoval Vallarta, "On Compton's Latitude Effect of Cosmic Radiation," *Physical Review*, *43* (1933), 87-91. In a recent exposition of Lemaître's cosmogeny, Helge Kragh finds it unproblematic that Lemaître ignored Clay. Kragh, "The Beginning of the World: Georges Lemaître and the Expanding Universe," *Centaurus*, *32* (1987), 114-39.

60 LMB. Compton to Clay, 6 Mar 1937, where Compton describes his good deed of the preceding year.

61 LMB. Hess to Clay, 27 Jan 1936.

62 Andr V., "De Corpusculaire Natuur der kosmische straling," *Algemeen Handelsblad*, 25 Feb 1933.

63 "Kosmische Straling; Prof. dr J. Clay over zijn jongste onderzoekingen; Zijn theorie bevestigd," *De Telegraaf*, 26 Jan 1934; "Geheimen der kosmische stralen; Wat prof. Clay vond; De corpusculaire [*sic*] aan de stralen bevestigd—Ook negatieve deeltjes; Nog veel in het duister gehuld," *De Telegraaf*, 6 Feb 1934.

*Algemeen Handelsblad* followed in 1935 with a feature about the "fundamental proof of the discovery of Prof. Clay" that, contrary to Millikan's assertions, stellar novas were not the origin of cosmic rays. The newspaper continued that Clay's "pathbreaking researches can definitively state the erroneousness of Millikan's theory."[64] Clay himself described the observations of Nova Herculis by Werner Kolhörster at Potsdam and by Woltjer at Bandung, and the evidence that they provided against Millikan's view of cosmic rays originating in supernovas, in a newspaper article of that year.[65] The stakes escalated through the early 1930s. When Clay had delivered his inaugural address at Amsterdam in 1929, he gave much space to Millikan's observations and speculations.[66] Six years later the Netherlands had to know, in Clay's view, about Millikan's failures.

By the time that Clay sallied forth against his nemesis, Millikan was bursting with pride and self-importance. When he and amanuensis Neher published a claim proposing themselves as leaders of the field in the *Physical Review*, Compton decided to expose the Pasadena Babbitt as a fraud. He drafted a long reply and invited Clay to be its coauthor. Compton clearly recognized that, by 1932, Clay's findings had been confirmed by researchers from a number of countries. Millikan stood guilty of experimental incompetence and, worse, calumny. He claimed for himself Clay's discovery of a variation of cosmic-ray intensity with longitude (explained by Clay as a result of the displacement of the axis of the earth's magnet from the earth's center), as well as several other results of Clay's.[67]

Clay replied quickly to Compton's initiative. He was "in complete agreement" with it, but he preferred to append a statement of his own to the draft. "It is only necessary," Clay added, that Compton "take care that the editors of the *Phys. Rev.* don't refuse my paper, as they have done once before." Clay continued:

> In former times it has worried me that Millikan had an offhanded ignorance for other work, but since I realized that his work was only of very little importance I had the feeling not to take him serious. But you are right to think otherwise, because he has the authority of his former work by all which don't know him in the Cosmic Ray field.[68]

In his companion piece, Clay stated:

64 B., "Waar komen de kosmische stralen vandaan? Fundamenteele betekenis van de ontdekking van prof. Clay," *Algemeen Handelsblad*, [1935], in BOC.

65 Clay, "Oorsprong der kosmische straling," *De Telegraaf*, 12 Apr 1935. Woltjer, "Cosmische Straling en Nova Herculis," *NT*, *95* (1935), 126-7.

66 Clay, *Het Kortgolvige Einde van de reeks der electromagnetische trillingen; Rede, uitgesproken bij de aanvaarding van het ambt van hoogleeraar aan de Universiteit van Amsterdam op maandag 14 october 1929* (The Hague, 1929), reprinted from *Physica*, *9*, 10.

67 LP. Compton to Clay, 3 Sep 1936; three drafts of Compton's paper, "Precision Surveys of Cosmic Ray Intensity."

68 LP. Clay to Compton, 16 Sep 1936, draft (in English).

> I fail to understand why Millikan in recent years has not followed the common practice in science of comparing his own results with those of other workers in the same field, and of including the latter in the general discussion. If he had done this he would have found that he has not obtained the precision, reached of late by others.

In Clay's view Millikan's work had no value.[69] Compton rewrote his part of the collaborative venture to make the case entirely unambiguous:

> Were it not for the evident value and apparent high precision of the data and the importance of the conclusions that are stated as if new, one might pass without comment over the fact that the authors [Millikan and Neher] have failed to refer to any except one of the many earlier studies of the same subject by other investigators. . . .
>
> The fact emerges that the cosmic ray survey of Millikan and Neher is not unique with regard either to its precision or its extensiveness. . . . All of their valid experimental generalization had, however, already been established by the studies of other investigators, and of their more important theoretical deductions some had been established before their papers were written and the remaining owners [*sic*] are unjustified.[70]

The editor of the *Physical Review* initially encouraged Compton's project.[71] Compton then rerouted the two manuscripts to the companion publication of the American Physical Society, *Reviews of Modern Physics*. He had to dodge thunderbolts from Pasadena. Compton informed Clay, early in 1937, that Millikan considered their papers as a personal attack and asked for a third party to write a dispassionate review of them. Compton preferred someone on the order of Karl Darrow or Thomas Johnson—two physicists working in non-university settings—but if such a person could not be found, then Compton was in favor of proceeding with publication.[72] Early in 1938, however, Compton withdrew his article from the *Reviews*, which then returned Clay's contribution to Amsterdam.[73]

Clay continued to defend his claims honorably. In a draft of a review of Millikan's book of 1939 on cosmic rays, Clay wrote:

> From the beginning of his work on cosmic rays up to 1933 he has unfortunately been on the wrong side with nearly all his own experiments and conclusions. This fact would be of no importance, if Millikan had not afterwards tried to turn the

69 LP. Clay, "'Precision' Surveys of Cosmic Ray Intensity," manuscript, n.d.

70 LP. Compton, "'Precision' Surveys of Cosmic Ray Intensity," manuscript n.d.

71 LP. Compton to Clay, 25 Nov 1936.

72 LMB. Compton to Clay, 11 Jan 1937.

73 LP. John T. Tate to Clay, 20 Jan 1938.

> facts in such a way that they prove that he has been right; and partly he tries to attain his end by distorting the results of others and depreciating their work, viz. that of Hess, Kolhörster, Clay and [Paul] Kunze.[74]

And in the July-October number of *Reviews of Modern Physics*, given over to the proceedings of a conference on cosmic rays at the University of Chicago, two papers of Clay's appeared first.[75] It is probably no less difficult for illustrious scientists than for ordinary people to admit publically that their judgment erred. Scientists whose theories are unsupported by evidence tend to act like generals who have lost a battle: They seek exoneration by appealing to extenuating circumstances. Millikan is diminished by his actions during the 1930s. Jacob Clay deserves only our admiration and attention.

## A Tradition of Research Institutionalized

Though denied a Nobel prize, Clay flourished in Amsterdam and his former institute carried on in Bandung. Clay's successor there, H. R. Woltjer, had been his temporary replacement in 1927-28. Woltjer, who received a doctorate in 1914 for a dissertation on spectroscopy directed by Pieter Zeeman, chose to go to Bandung instead of competing for a chair at the Reformed-Church controlled Free University in Amsterdam, where, according to Wander Johannes de Haas, "he is not sure whether, in the neighborhood of the snake, there would not be a ventriloquist next to him."[76] Woltjer demanded unfettered intellectual freedom. His approach to religion resembled that of James Clerk Maxwell; one could be a God-fearing Christian while maintaining the confidentiality of the relationship between man and the Deity.[77] Over the fifteen years between the end of his student days and the Bandung call, most of his research focused on the physics of low temperatures. It appeared in print methodically and undramatically.

Woltjer took up his post at the onset of the Great Depression, when, especially in the East Indies, science and scientists suffered reductions in funding.[78] He settled into teaching the sixty new students and worried over the possibility that the Batavia medical school would call on him to teach

74 LP. Clay, "Millikan About the Latitude Effect of Cosmic Rays," manuscript, n.d.

75 Clay contributed, alone or in collaboration with colleagues, five papers. Typically, Seth H. Neddermeyer and Carl D. Anderson—Millikan's protégés—did not mention Clay in the historical summary to their paper. Compton introduced the issue. All in *Reviews of Modern Physics*, *11* (1939), 122 ff.

76 LMB. De Haas to Clay, 5 Jan 1929.

77 Woltjer, "Over De Verhouding van James Clerk Maxwell als natuurkundige tot den Bijbel," *Gedenkboek der Societas Studiosorum Reformatorium ter gelegenheid van haar 8ste lustrum 1886-1926* (Rotterdam, 1926), pp. 144-51.

78 LMB. Woltjer to Clay, 7 Oct 1931, where Woltjer relays salary reductions of 30%.

future physicians about exact observation.[79] The educational enterprise faced a generally bleak prospect. It sustained criticism that called it "a scandal of an enormous waste of money, which continues without interruption in the picturesque landscape where the TH has erected its exotic buildings."[80] In fact, however, the TH cost much less than comparable institutions in the Netherlands. It had only seven full-time professors, who nevertheless produced first-rate engineers. A student who completed two years at the TH would have to pass only one additional examination to be credited for a third year at Bandung's sister institution in Delft.[81] Standards remained high because the professors sought to eliminate concessions for poor preparation on the part of the students. Around 1930, the student body was approximately 60% European, 33% Indonesian, and 7% ethnic Oriental.[82] Woltjer reflected on the year-end examinations in 1931. Of the 62 students who began the first year, some dropped out; 16 passed their examinations, 13 went on probation, and around 27 failed. He favored more rigorous standards, although the enterprise had an increasingly hazy goal: "It will be hard to find a post for the engineers who finish," he wrote to Clay.[83]

Woltjer set his house in order. He got along well with his chief assistant, August Juliaan Leckie, who had in 1919 completed a doctorate under De Sitter and whom Woltjer thought "very capable and conscientious and also extremely energetic."[84] He received overtures from researchers at Potsdam to carry out cooperative research into cosmic rays, and he thought to do something in this direction without reducing Bandung to a German "branch" operation. He chafed at the prospect of undertaking meteorological research, and he thought that statistical and photographical data registration belonged not in the physics laboratory but at the Batavia meteorological observatory.[85] Woltjer soon received renewed stimulation when, in 1933, Clay succeeded in organizing a cosmic-ray expedition to Java. Clay, offered free passage by a shipping company, brought with him four assistants and stores of balloons, hydrogen gas, and counters.[86] He

79 LMB. Woltjer to Clay, 29 Jul 1930.

80 Letter of v. L., 10 May 1932, published in *Gooi- en Eemlander*, in LMB, Arch. 234 D.

81 *Ibid.*, reply of the Dean of the TH.

82 Racial breakdown in *ibid.* In 1928, Europeans had constituted 67% of the TH students. *Universiteiten en hoogescholen* [note 11], p. 77.

83 LMB. Woltjer to Clay, 7 May 1931.

84 LMB. Woltjer to Clay, 29 Oct 1930. Leckie, *Analytical and Numerical Theory of the Motions of the Orbital Planes of Jupiter's Satellites: Secular Terms* (diss., Univ. Leiden, 1919).

85 *Ibid.*

86 LMB, Arch. 234 B. Clay, untitled and undated manuscript in folder, "Expeditie kosmische stralen naar Indië ± Okt 1930," where the free passage on the ship "Tajandoen" is mentioned. His assistants were Cornelis Gerardus 't Hooft, Michael Rutgers van der Loeff, Pieter Martinus van Alphen, and N. Breedeveld. A photograph of the departing group appears in an unknown newspaper on 27 Sep 1933, in BOC. 't Hooft and Rutgers van der Loeff received doctorates under Clay (in 1950 and 1938); Van Alphen received his for low-temperature physics under W. J. de Haas at Leiden in 1933.

17. Balloon landing during Jacob Clay's cosmic-ray expedition, Bandung, 1933-34. Courtesy of Mevr. Nelke van Osselen-Clay, Bilthoven.

took away significant data and left Woltjer with an agenda of unfinished business.[87]

Publications issued from Woltjer's operation by Leckie and other assistants, King Liong Yap and Go Pok Oen, on questions relating to atmospheric physics. Researchers at the Bosscha Laboratory had the good sense not to become involved in the controversy between Tettje Clay-Jolles and Maarten Pieter Vrij, Boerema's assistant at Batavia, over ultraviolet radiation in the tropics. Woltjer found his diplomacy rewarded when, in 1936, Clay wrote to ask if he would agree to succeed Zeeman at Amsterdam as an associate professor and laboratory director. Woltjer declined. It was not that he wanted to stay in Bandung, he emphasized, even though his colonial position was "superb in many respects," for two of his children were then in the Netherlands. Rather, Woltjer gathered from Clay's letter that Zeeman was approaching Ornstein about the post: "I do not want to work against that, even though I understand that Van der Waals and you have objections and I do not know why Zeeman wishes it that way." Woltjer, an astute judge of academic politics, would apply only if Zeeman were supporting him.[88] The Bandung situation was declining, and he had no objection to returning home in a diminished rank.

Woltjer stayed on at Bandung through the fall of the Netherlands in

87 Woltjer comments on the variation of cosmic rays with barometric pressure, using data taken according to Clay's instructions, in "Variaties in de cosmische straling," 7° *NINC Hand.* (1935), pp. 116-20. Also: Clay and Woltjer, "Diurnal Variation of Cosmic Rays," *Physica*, *2* (1935), 582-4.

88 LMB. Woltjer to Clay, 15 Dec 1936.

1940 and of the Netherlands East Indies in 1942. He survived internment in a Japanese concentration camp. Circumstances did not permit him to leave his own mark on research at Bandung, although his more practical-minded colleagues in geology and engineering seem to have been able to push back the frontiers in their disciplines.[89] Woltjer continued the tradition that apprised the prime mover of Indonesian independence, Soekarno, of pure science and its promises.[90]

## Medical Education in Indonesia

Physics early in the twentieth century was an imperialist discipline. Its practitioners, once they received training in a university laboratory, found permanent appointments in a wide variety of institution, and they undertook to apply their knowledge to virtually any situation that presented itself. Jacob Clay's itinerary from cryogenics to philosophy to cosmic rays is not untypical of the period. We have seen how, on Java, physics found a secure niche at the Royal Magnetical and Meteorological Observatory in Batavia and at the Bandung Institute of Technology. A second Batavian institution also provided a focus of operations for a talented Dutch physicist and his wife. The couple are Bernardus Jan van der Plaats and Agathe van der Plaats-Keyzer; the institution is the medical school. Medical physics, the same as cosmic-ray physics, came to Java with the establishment of university-level instruction for Indonesians.

During the first half of the nineteenth century, medicine in the Dutch East Indies conformed to the prevailing imperial pattern: Military authorities dispensed and controlled it. The initiative of the director of the colonial medical service, Willem Bosch, resulted in 1851 in the creation of a School for the Training of Native Physicians (School tot Opleiding van Inlandsche Artsen, universally known by its acronym *Stovia*) on the site of the military hospital in Batavia's suburb of Weltevreden. In 1851 twelve pupils began instruction in the Malay language, Dutch, arithmetic, geometry, European and Indonesian geography, astronomical geography, inorganic chemistry, physics, mechanics, geology, botany, zoology, anatomy, physiology, pathology, midwifery, and surgery. The first graduates took their oath as "vaccinateur en Inlandsche genees- en heelkundige" in 1855; beginning in 1859 the diplomas proclaimed the successful candidate as a "doctor Djawa" without further qualification.[91]

89 A generally equitable survey of physics in the 1920s and 1930s, especially, is found in Woltjer's "De Ontwikkeling der natuurkunde in Indonesië gedurende de 100-jarige werkzaamheid der Koninklijke Natuurkundige Vereeniging," in *Eeuw*, pp. 32-40.

90 Ricklefs, *Modern Indonesia* [note 1], pp. 172-4, 176-80. In *Jaarboek, Lustrum-Uitgave* [note 10], Soekarno is listed as having graduated in 1926, but no employment is noted. (In 1935, when the *Jaarboek* appeared, he was exiled to the island of Flores after having served a prison sentence for sedition.) Upon graduating, Soekarno declined the offer of a lectureship in architecture at the TH. C. L. M. Penders, *The Life and Times of Sukarno* (Rutherford, N.J., [1974]), p. 11.

91 *Ontwikkeling*, for the official history of the first seventy-five years of Stovia; G. M. Lauw, *De*

Medical education on Java in the nineteenth century equalled or surpassed that in *any* other imperialist setting, the British overseas dominions included. As the course of study progressively lengthened, Stovia became the pinnacle of the educational pyramid in the East Indies. The school received a major impulse from its director during the years 1887-96, Christiaan Eijkman, who concurrently headed a laboratory in the Weltevreden military hospital. Eijkman lived up to the impressive academic pedigree that he had acquired in Europe: During his tenure at Stovia he carried out research on beri-beri which would later win him a Nobel prize.[92] In 1902, with a new building for the school (which received substantial funding from private sources), came a change in the title of the school's diploma: A graduate was no longer merely a "doctor Djawa" but rather an "Inlandsch arts," a native physician.[93] By 1900 around 200 Indonesians had acquired the doctorate and found their way into medical practice.[94]

The reorganization of 1902 reflected rising interest in basic sciences, following regulations in Europe whereby medical students had to acquit themselves in physics. The time required for medical courses went from five years to six, and a preparatory division extended from two to three. The new building had a lecture hall for instruction in chemistry and physics, and a military apothecary, Pieter Adriaan Boorsma, came to teach these subjects. Part of Boorsma's charge involved publishing, in 1903, a physics textbook.[95] Reforms proceeded apace. In 1913 the medical school prescribed a seventh year of study, the diploma changed from "Inlandsch arts" to "Indisch arts," and a second school on the Stovia model opened in Soerabaja. Three years later construction began on a large complex for the main school at Batavia. The building had a separate lecture hall for physics, as well as a physics reading room and laboratory.[96] Simon Willem Visser from the magnetical and meteorological observatory, located near the school, taught physics until around 1922 when he remanded his task to Simon Petrus Slagter, who had just received a doctorate under physicist Ornstein at Utrecht.[97] In 1922, two generations after its Dutch counterparts, Stovia successfully negotiated the sex barrier—no small achievement

*Dokter Djawaschool: De eerste medische opleiding voor inheemsen in Nederlands Oost-Indië 1850-1875* (diss., Univ. Nijmegen, 1979), for a recent reevaluation. Here *Ontwikkeling*, p. 3 and Lauw, pp. 65-6 (for diplomas). The wider background in medicine and public health is given in D. Schoute, *De Geneeskunde in Nederlandsch-Indië gedurende de negentiende eeuw* (Batavia, [1935?]); D. Schoute, *Occidental Therapeutics in the Netherlands East Indies During Three Centuries of Netherlands Settlement (1600-1900)* (Jakarta, 1937).

92 In J. P. Fockema Andreae, *et al., De Utrechtsche Universiteit 1815-1936* (Utrecht, 1936) [*De Utrechtsche Universiteit 1636-1936, 2*]: B. J. Kouwer, "Medische Faculteit," pp. 215-73, on pp. 236-7. "Eijkman," *DSB, s. v.*

93 *Ontwikkeling*, pp. 97, 340.

94 *Ontwikkeling*, pp. 349-52, for graduates from 1877 to 1900; Lauw, *Dokter Djawa* [note 91], 162-5, for graduates up to 1877.

95 *Ontwikkeling*, pp. 43, 47.

96 A detailed architectural plan is provided in *Ontwikkeling*, pp. 100-101.

97 *Ibid.*, pp. 345, 366. Slagter, *Adsorptiemetingen aan solen* (diss., Univ. Utrecht, 1921).

in a Muslim country—when it granted a doctorate to Marie Thomas.[98]

Stovia enjoyed the attributes of a university faculty without being an official part of higher education in the East Indies. The Bandung Institute of Technology opened in 1920 and became a charge of the colonial government in 1924; a law school, the Rechts-Hoogeschool, opened in Batavia, also in 1924. The year after it celebrated seventy-five years of existence, Stovia received the title, in 1927, of Geneeskundige Hoogeschool. The medical school henceforth possessed all the rights and privileges of its sister institutions in the Netherlands. To carry out its tasks, the school hired additional faculty. Bernardus Jan van der Plaats, a physicist-physician responsible for the radiological clinic at the University of Utrecht, accepted a call to become associate professor of radiology.

## The Essence of a Scientific Echtpaar

The lives of Bernardus Jan van der Plaats and his wife, the former Agathe Keyzer, parallel those of Jacob and Tettje Clay. Both couples met in the context of their university studies. In each case the man taught school, received a doctorate in physics, and worked as a post-doctoral assistant in the laboratory of his thesis adviser. Both Van der Plaats and Jacob Clay then turned away from experimental physics and toward a new and related specialty—Van der Plaats in radiology and Clay in philosophy of science. After acquiring certification in the specialty—Clay through his books and Van der Plaats by obtaining a medical license—each man received a call to become a professor in a new colonial faculty. Both women were skilled professionals—Tettje Clay was *doctoranda* in physics and Agathe van der Plaats was a practising physician—but each sublimated her scientific interests in the career of her husband. At the time of marriage, each woman was wealthier than her intended mate.

To what is the similarity due? Ambitious and domestically settled men with proven administrative skills would evidentally be high on anyone's list for setting up an academic program, and any new professor would also be required to have pushed out the frontiers of pure learning by publishing the results of original research. This much is true for all academic fields, from medieval history to comparative philology, whether in metropolitan or peripheral settings. Understanding the similarity between the Van der Plaatses and the Clays depends on a reading of the physics discipline in the Netherlands.

The exact sciences, and especially physics, leaped to prominence at the beginning of the twentieth century. Spectroscopy flourished under Zeeman at Amsterdam and Julius at Utrecht; Kamerlingh Onnes pioneered low-temperature physics at Leiden; theoretical physics at Leiden under Lorentz and at Amsterdam under Van der Waals, received world

98 *Ontwikkeling*, p. 80.

attention. Kapteyn at Groningen was one of the world's leading astronomers. Talented younger men—De Sitter in astronomy at Leiden and Brouwer in mathematics at Amsterdam—advanced through the ranks. Foreigners—Ehrenfest in theoretical physics and Hertzsprung in astrophysics at Leiden—succeeded to key posts.

Three revolutions drew talented students into physics during the years after 1900. The first, then occuring in the laws of physics, was a revolution explicitly acknowledged in German-speaking Europe just to the east of Dutch borders.[99] The second revolution was Holland's rapid industrialization, having begun only in the 1890s.[100] An ambitious student did not have to look far to realize that, if he or she failed to land a sinecure allowing exploration of the subatomic world, a physicist's skills would open the door to a position in industry. The third revolution was that in women's education, whereby girls at last received preparation for university studies. Having been segregated by sex in the secondary schools, young women experienced few pressures to suppress or sublimate the pleasures of intellectual achievement.[101]

Women's education came to much of northern Europe in one mold, and for this reason the Dutch situation in physics, *circa* 1900, would seem to be *specified* by the first two of the foregoing revolutions. Although the physics revolution found expositors who for the most part wrote in the German language, the great majority of professors in the German, Austrian, and Swiss-German physics communities played only a small role in developing or extending it. The revolutionary ideas and experiments originated in only a handful among the fifty-odd German-language universities and institutes of technology. Around 1910, the Netherlands had five major institutions of higher learning—the national universities at Leiden, Utrecht, and Groningen, the national polytechnical school at Delft, and the municipal university at Amsterdam—and all were in the forefront of the exact sciences. The Dutch academic community has, since the late nineteenth century, played a role in physics beyond what its numbers might suggest. As far as industrialization goes, by 1910 Germany and the United States (and their weaker sisters, France and Britain) had already gone well into iron and steel, railroads, chemicals, and electrification, and scores of specialized technical schools provided managers for these enterprises. Dutch industrialization, happening so quickly and so late, resulted in a fluid situation where demand for engineers outstripped the available supply.

Ambitious men and the ambitious women behind them require flexibility to succeed. Ambition gratified is nothing less than a successful

99 For part of the physics revolution, Lewis Pyenson, "The Relativity Revolution in Germany," in *The Comparative Reception of Relativity*, ed. Thomas Glick (Dordrecht, 1987), pp. 59-111.

100 J. A. de Jonge, *De Industrialisatie in Nederland tussen 1850 en 1914* (Amsterdam, 1968).

101 Generally: Jan Romein, transl. Arnold Pomerans, *The Watershed of Two Eras: Europe in 1900* (Middletown, Ct., 1978), pp. 601-17; H. P. Hogeweg-de Haart, "The History of the Women's Movement in the Netherlands," *Netherlands' Journal of Sociology*, *14* (1978), 19-40.

adaptation in society. The prestige and skills implied in a physics doctorate provided a springboard enabling both Clay and Van der Plaats to establish themselves in neighboring fields. Ambition drove them to accept a new opportunity in the East Indies; assiduity brought success to the enterprise. Their decision was a socially acceptable alternative to occupying second- or third-rank academic positions in the Netherlands. In the years after 1918, planters, traders, and civil servants retired from the Indies to live in baronial splendor. One could pursue a calling while hoping for a call to the motherland. An impressive colonial pension would be consolation enough if one were not elevated to the ranks of the chosen.

## Metropolitan Origins of Colonial Radiologists

Agathe Keyzer and Bernardus Jan van der Plaats were each born in 1888, and their careers are typical of the period. Keyzer, coming from a well-provided family, went to schools in the Netherlands and Germany. In 1906 she qualified to teach gymnastics and in the following year received an elementary-school teaching certificate. She practised her profession and, not having graduated from a *gymnasium*, studied for the examination whose mastery would allow her to attend university. She entered the University of Utrecht as a student of astronomy but in 1914 changed to medicine. Within a year she had met her future husband, most probably in the Utrecht physics institute where he was working toward his doctorate.

At this time Van der Plaats conducted himself in the manner expected of a young *doctorandus*. Beginning in 1910 he taught physics and chemistry at the Burgeravondschool in Utrecht, a municipal evening school, netting him *f*440 per annum. Also in 1910 he became assistant without salary in the physics laboratory of Willem Henri Julius. In 1912 the Burgeravondschool position became permanent (Van der Plaats began contributing to a retirement pension), and Julius placed his assistant on the payroll first at *f*600 per annum and then, two months later, at double that. In 1914 he took on an additional physics lectureship at an Utrecht HBS for around *f*640. When Agathe Keyzer met him, Van der Plaats was pulling in *f*2280 per annum. Her inheritance provided enough for marriage. The nuptials took place in 1917, shortly after Van der Plaats defended his dissertation.[102]

102 These and subsequent dates and figures come from receipts and documents provided me by Dr med. Gerardus J. van der Plaats of Maastricht. Document and title references shall not always be noted separately in the present text. Van der Plaats receives an entry in G. A. Lindeboom's *Dutch Medical Biography* (Amsterdam, 1984), *s. v.*, which is for the most part accurate. A major éloge is by J. R. von Ronnen, "Herdenking van Prof. Dr B. J. van der Plaats," *Journal belge de radiologie*, *41* (1958), 241-8. The *Nahbestrahlungsröhren* attributed to Van der Plaats by Hans R. Schinz, *60 Jahre medizinische Radiologie: Probleme und Empirie* (Stuttgart, 1959), pp. 58, 154, were developed by B. J.'s younger brother G. J. It should be emphasized that by the time that Agathe Keyzer began her studies, women had been accepted into the Dutch medical corporations. Aletta Jacobs was the first woman to receive a Dutch medical doctorate, from Groningen in 1878. By the turn of the century, around a dozen women had completed medical studies in the Netherlands. In 1913 there were 72 practising women physicians and 171 women medical students. E. Pereira-

Van der Plaats worked for seven years under Julius to finish his dissertation on dispersion lines.[103] When Van der Plaats first became an assistant in the physics laboratory, his fifty-year-old adviser was reaching toward the height of his career as a solar astrophysicist. The decision of a physics laboratory director to devote himself to observational astronomy would have been unusual anywhere except in the Netherlands, where it was normal during the twentieth century for a scientist to cross disciplinary frontiers that, in Germany and France especially, were walled off in stone.

Julius had taken a doctorate at Utrecht under the professor of physics Buys Ballot and continued as an assistant of Buys Ballot's in the new Utrecht physics laboratory. He persisted at his post when his uncle, Victor August Julius, succeeded to Buys Ballot's chair in 1888. Two years later W. H. Julius became associate professor at the University of Amsterdam. He returned in 1896 to direct the Utrecht laboratory when V. A. Julius moved into to the chair of theoretical physics then vacated by V. A.'s dissertation adviser, Cornelis Hubertus Carolus Grinwis. W. H. Julius spent much time in his early years as director teaching the influx of medical students. He gradually acquired funds for several assistants, one of whom, Willem Jan Henri Moll, becoming *lector* in 1909.[104]

Van der Plaats arrived on the scene just as Julius, the veteran of several solar-eclipse expeditions and a visit to George Ellery Hale's observatory on Mt Wilson in California, was beginning to plan for a solar observatory of his own. During Van der Plaats's years as Julius's assistant, three talented researchers successively occupied the Utrecht chair of theoretical physics—Cornelis Harm Wind, Petrus Josephus Wilhelmus Debye, and Leonard Salomon Ornstein—although, tied into his daily tasks, Van der Plaats remained deaf to the siren call of theory. He published a paper with Julius on anomalous dispersion in gases and another on absorption and dispersion of light in solutions of dyestuffs.[105] His doctoral thesis, defended in 1917, garnered him within some eighteen months the chief assistantship under Julius at *f* 3000 per annum. But by this time his interests had turned toward medicine, and in particular radiology.

Radiology now belongs to the world of medicine. Medical corporations in the capitalist and precapitalist world, existing largely to control what is perceived as vital wisdom for the pecuniary benefit of their constituents, have traditionally done little in the way of monitoring therapeutic prac-

d'Oliveira, *Vrouwen Feministen die van genezen wisten; Over de vrouwelijke arts in Nederland* (Amsterdam, 1973), pp. 21, 36; *Van Moeder op dochter* [note 13], pp. 98-9, 108-13;

103 Van der Plaats, *Dispersielijnen* (diss., Univ. Utrecht, 1917).

104 Physics at nineteenth- and twentieth-century Utrecht is recounted by W. J. H. Moll in his contribution to the second volume of the tercentennial history of the university, *De Utrechtsche Universiteit 1815-1936* [note 92], pp. 281-90. On V. A.: V. A. Julius, *De Leer der quaternions in hare toepassing op de leer van den circulairen hodograaf* (diss., Univ. Utrecht, 1873).

105 Julius and Van der Plaats, "Observations sur la dispersion anomale de la lumière dans les gaz," *Archives néerlandaises, 2* (1912), 1-6 (also in the *Zeitschrift für wissenschaftliche Photographie*); Van der Plaats, "Untersuchungen über Absorption und Dispersion des Lichtes in Farbstofflösungen," *Ann. Phys., 47* (1915), 429-62.

tices and diagnostic procedures. Especially before the advent of public-interest legislation, physicians peddled their services in a free-market or free-for-all economy. By the end of the nineteenth century, antisepsis, vaccination, and biologically active serums and chemicals conspired to invest medical men and women as scientifically credible merchants of life and death, but these innovations existed within a broad spectrum of electrical and chemical practices. It is not surprising that the medical world immediately embraced X rays as a new tool for therapy and diagnostics, just as it did the contemporaneous discoveries in phototherapy of Nobel-laureate Niels Ryberg Finsen. The following generation witnessed what we have come to expect of the licensed medical community: lack of concern for the well-being of patients, inability to evaluate revolutionary developments in exact sciences, and claims bordering on charlatanry.[106]

During the First World War, the belligerent powers all employed diagnostic X-ray units as a regular part of military medicine. Furthermore, as Daniel Serwer has pointed out, a number of physicists altered their career plans to take advantage of this expanded government interest and the funds attached to it.[107] Dutch scientists—serving as conduits for communicating research between the Triple Entente and the Central Powers—were well aware of foreign developments in medical X rays.

A relatively flexible system of higher education permitted Van der Plaats to ride the crest of the wave and forsake physics for medicine. Over the past century the Dutch scientific community has generally been quick to reward innovative and talented researchers. The first associate professorship of radiology and neurology at a Dutch university, the municipal one in Amsterdam, came in 1899 to Johannes Karel August Wertheim Salomonson. Rising to the heights of the Amsterdam Academy of Sciences in 1912, Wertheim Salomonson received a chair at Amsterdam in 1915 and, in 1921, the university rectorship. Other early Dutch radiologists included the internationalist physician Pieter Hendrik Eijkman (brother of Nobel-laureate Christiaan Eijkman), who labored until his death in 1914 in the neighborhood of The Hague, and Wertheim Salomonson's successor Nicolaas Voorhoeve.[108] The way having been pointed by avant-gardist scouts,

106 These and related matters are treated in the persuasive study by Daniel Paul Serwer, *The Rise of Radiation Protection: Science, Medicine, and Technology in Society, 1896-1935* (diss., Princeton Univ., 1976) [appearing as *Brookhaven National Laboratory 22279, Informal Report* (Upton, New York, 1976)]. Also: Stephen B. Dewing, *Modern Radiology in Historical Perspective* (Springfield, Ill., 1962). Of some use are retrospective accounts in the *American Journal of Roentgenology and Radium Therapy*, *24* (1930) [by W. D. Coolidge, pp. 605-20]; *26* (1931) [by James T. Case, pp. 511-16, and H. M. Imboden, pp. 517-22]; in *Radiology*, *45* (1945) [by Paul C. Hodges, pp. 438-48, Leo G. Rigler, pp. 467-502, and George E. Pfahler, pp. 503-21]; and in the *American Journal of Roentgenology, Radium Therapy, and Nuclear Medicine*, *75* (1956) [by Otto Glasser, pp. 7-13, William J. Tuddenham, pp. 659-67, and Kenneth L. Krabbenhoft, pp. 859-65].

107 Serwer, *Radiation Protection* [note 106], pp. 131-5.

108 J. Cobben, "Nederlandse Pioniers in de radiologie," *Journal belge de radiologie*, *42* (1959), 738-45. P. H. Eijkman, *L'Internationalisme scientifique* (The Hague, 1911); W. A. H. van Wylick, "Beiträge aus den Niederlanden zur Entwicklung der Röntgenologie und Beziehungen auf

radiology presented itself a field waiting to be colonized by enterprising physicists.

Van der Plaats's training in the physics of radiant energy provided a natural entry into the world of medicine. In his doctoral dissertation, he had already defended a "thesis" on the importance of physics for medical doctors. It was something that his wife, as a medical student, knew first-hand. When Julius received an appeal in 1917 from the Utrecht professor of surgery Hiddo Jan Laméris for a candidate to set his X-ray apparatus in order, Van der Plaats stepped forward. At the time, medical clinics in various specialties had separate facilities for radiology. The equipment resided with the junior assistant, who, even if interested in his charge, generally lacked a proper understanding of it; radiology, as a clinical specialty, had not yet achieved the status of a laboratory discipline. Laméris's assistant Cornelis Hendrikus Kok had worked on his medical dissertation in Julius's laboratory during 1916; and Van der Plaats was his *cicerone* there.[109] Responding to an evident need, Van der Plaats and Kok decided to set up an independent institute for radiology in Utrecht at just the time that analogous institutions emerged in Amsterdam and Rotterdam.[110]

Van der Plaats actually abandoned academia for private enterprise in 1919. He resigned his paying posts in the secondary schools and in Julius's laboratory, devoting himself to a succession of radiological operations located (through the patronage of Laméris) in one or another Utrecht hospital. But Van der Plaats, who had become a man of independent means, could not do without university intercourse. He soon persuaded Julius to reappoint him as an unpaid assistant and then joined his wife as a student of medicine. In 1920, the new professor of internal medicine at Utrecht, Albert Abraham Hijmans van den Bergh, asked Van der Plaats to reorganize the radiological section of the clinic for internal medicine. He returned to the university in 1921 as temporary *conservateur* and then in the following year as regular *conservateur* for radiology in Hijmans van den Bergh's clinic. There his salary soon rose to *f*4200—a handsome supplement to his wife's income. He qualified as a state-licensed physician in 1924. Agathe van der Plaats-Keyzer qualified later in the same year, after having taken her final semesters of study in Groningen. Neither husband nor wife completed a medical doctorate. The reason for this circumstance

röntgenologischem Gebiet zwischen den Niederlanden und Deutschland," *Medizinisch-Technische Radiologie*, 5 (1974), 78-88. On Eijkman's internationalism: M. J. van den Hoven, "Internationalisme, volwasseneneducatie en syntheticisme," in *Filosofie in Nederland* [note 27], pp. 49-64, on pp. 51-3.

109 Kok, *Over Tuberculose van gewrichten* (Dr med. diss., Univ. Utrecht, 1916), thanking Julius and Van der Plaats in the introduction.

110 The intervention and patronage of Laméris, and the status of radiology, from von Ronnen [note 102], who however dates Van der Plaats's engagement with radiology from 1917; the Amsterdam and Rotterdam institutes from K. Breur, "De Ontwikkeling der radiologie," in *De Vooruitgang van de geneeskunde in onze eeuw*, ed. J. A. van Dongen (Amsterdam, 1966), pp. 240-8, on p. 248. On Laméris, Lindeboom, *Medical Biography* [note 102], *s. v.*

bears scrutiny.

Before the middle of the nineteenth century, the only diplomas offered by Dutch medical faculties were doctorates for a variety of medical specialties, each doctorate requiring a printed dissertation. The *medicinae doctor* demanded virtually no practical competence of its bearer, although the *chirurgiae doctor* and *artis obstetriciae doctor* did. A lecturer in a medical faculty had to be three-fold doctored, although some of the trinity of diplomas could be possessed *honoris causa*. In an attempt to assert federal authority over medical licensing, educational reformers, in 1865 and 1878, required that physicians pass an extra-university, state examination dealing with medical practice. Admission to the examination, however, did not depend on having completed a medical doctorate. *Doctores medicinae* as well as *doctorandi medicinae* (those who had succeeded in the courses required for a medical doctorate) were welcome to present themselves. In this way, the government effectively revived the medieval medical licentiate, which had been less expensive and less time-consuming than the doctorate, and which required no *proefschrift*.[111]

By the beginning of the twentieth century, the regimen allowed graduates of HBS to become physicians, the medical doctorate being reserved for alumni of a classical *gymnasium*. Neither of the Van der Plaatses had passed through a *gymnasium*—Bernardus graduated from a HBS in Utrecht, and Agathe studied privately to pass the HBS *staatsexamen*. It is likely that each aspired to become a second-class physician—state-licensed but unable to doctor a door plaque. The restriction, while potentially serious for an eye-ear-nose-and-throat specialist, mattered less for a radiologist.

The government brought about a modification in certifying procedures which directly affected the Van der Plaatses' careers. In 1921, responsibility for the licensing examination devolved on the universities, the latter assuming practical as well as scientific tasks. To sit for the licensing examination, a candidate had to have at least two years of extra-university, clinical experience. This change likely persuaded Bernardus to pursue medical studies at the university where he had been active for more than a decade. Agathe no doubt qualified at Groningen because she found curriculum and instructors more congenial there than at Utrecht.

The two new physicians practised in Utrecht, he directing a radiological clinic and she serving as an unpaid assistant. Van der Plaats became absorbed in the technology and practice of dosimetry, although he found

111 R. Drion and B. Drion, "Geschiedenis van de wetgeving op het gebied van de artsopleiding, het artsexamen en het artsdiploma," *Nederlands Tijdschrift voor geneeskunde*, *122* (1978), 1334-7, and the resulting discussion by W. Schuurmans Stekhoven and by Drion and Drion (*ibid.*, pp. 1675-6), and especially the remarks by G. A. Lindeboom (*ibid.*, pp. 1818-19). The superfluous nature of the doctorate, with regard to the practice of medicine, is discussed in *Min.*, *2* (1892/93), 16. M. Groen indicates four medical doctorates at the beginning of the nineteenth century. Groen, *Het Wetenschappelijk Onderwijs in Nederland van 1815 tot 1980; Een onderwijskundig overzicht. 1: De wetgeving* (Eindhoven, 1983) [*Eindhoven University of Technology Research Reports, Department of Philosophy and Social Sciences*, 83-WM-001], p. 56.

time to study the effects of X rays on nervous tissue; Van der Plaats-Keyzer published on tumors.[112] Then, in December 1927, came the break that most academics entering the middle phase of their career dream about. The secretary and dean of the new faculty of medicine in Batavia, Cornelis Douwe de Langen, was stumping the Netherlands on behalf of his institution and had just become the proud possessor of an honorary medical doctorate from Utrecht. De Langen had been *chef de clinique* under Hijmans van den Bergh. Seeking a radiologist for the public health service of the East Indies and also for his faculty, he naturally settled on Hijmans's assistant Van der Plaats.[113] Husband and wife sold their house and set off for the Indies. In December 1928, Van der Plaats took up his post at *f* 1050 per month. He concluded his oath of office in Batavia not with the usual words, "So truly help me God Almighty," but by affirming, without appeal to the Deity, "That I promise."

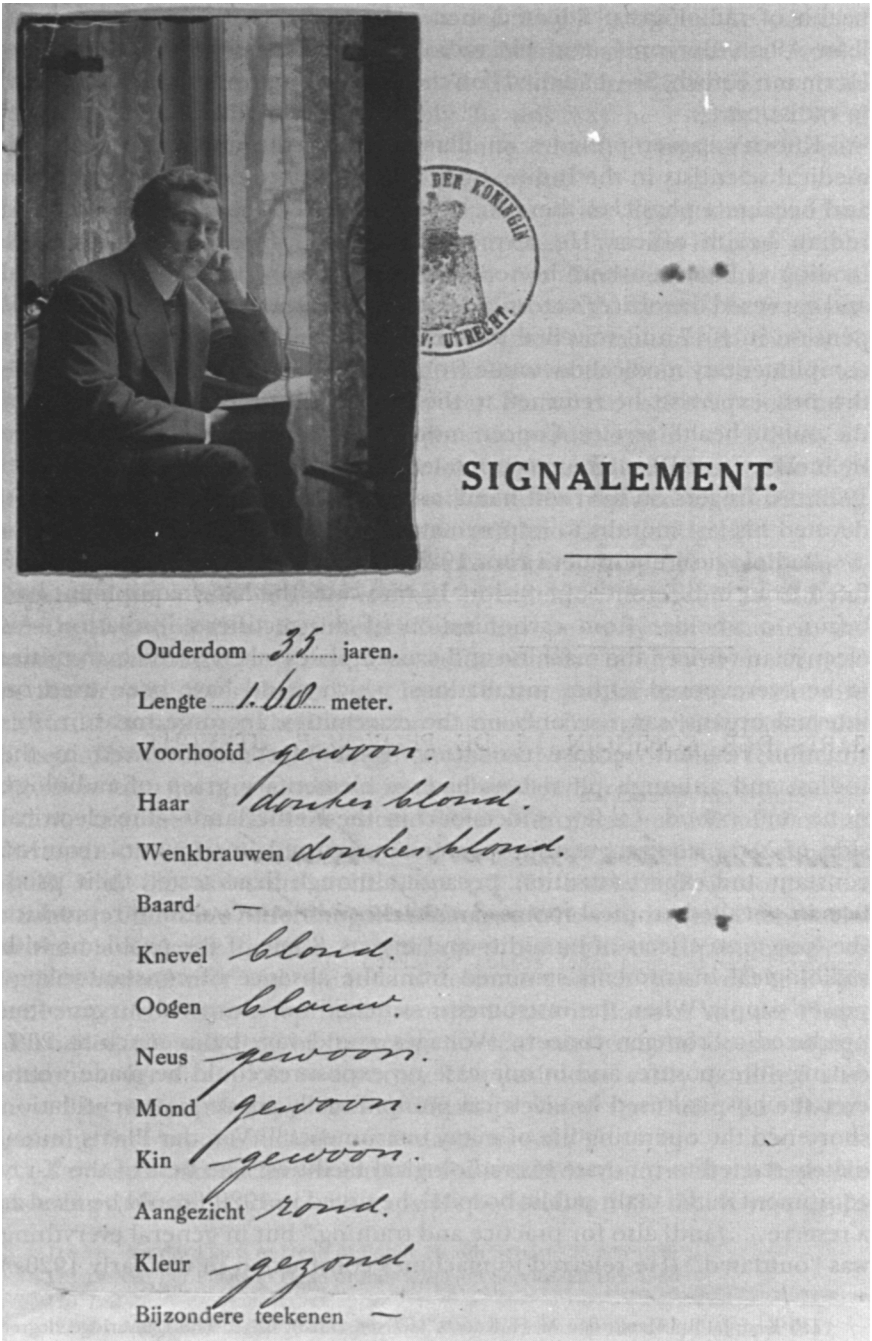
## Radiology in an Eastern Setting

In title, prestige, and remuneration, Van der Plaats had received a call to a university-level position. He acquitted himself accordingly. At Dutch universities a professor traditionally delivers and publishes both his inaugural and his valedictory lectures. In March 1928, Van der Plaats started his teaching career by providing a survey of radiology. He began by emphasizing its novelty: "When the course registers of various institutions of higher learning are examined for the place of radiology or radiation theory, it will be noted that this specialty is officially represented at relatively few universities."[114] This was so because of the rapid progress of the exact sciences over the preceding generation, especially in the area of radiation. The progress of medical radiology had not been so rapid, for medicine gave a large role to personal subjectivity, but the new specialty had nevertheless successfully established itself in clinical practice. In the early years of radiology, physicists directed radiological institutes. Van der Plaats intended in his address to persuade the faculty that the specialty had thenceforth to form a regular part of the medical curriculum. He discussed the therapeutic and diagnostic uses of radiant energy, beginning with infrared and ultraviolet light, passing on to X rays, and then considering radium. He concluded by emphasizing the hazard that X rays posed for the

112 E. Winkler-Junius and Van der Plaats, "The Influence of X-Rays on Fertilized Axolotleggs of Different Ages," *Amst. Proc.*, *32* (1929), 237-47. On Agathe van der Plaats-Keyzer's research, Pereira-d'Oliveira, *Vrouwen Feministen* [note 102], p. 113.

113 On De Langen's invitation, von Ronnen [note 102]; on De Langen and Hijmans van den Bergh, G. A. Lindeboom, *Geschiedenis van de medische wetenschap in Nederland* (Bussum, 1972), p. 170, and also Lindeboom, *Medical Biography* [note 102], *s. v.*; on De Langen's position and travels, the oration of J. Boeke in *Eerste Jaarboekje van de Geneeskundige Hoogeschool te Batavia, uitgegeven ter gelegenheid van den dies natalis op 16 augustus 1928* (Weltevreden, [1928]), pp. 55, 69-70.

114 Van der Plaats, *Toepassingen van de radiologie in de geneeskunde: Rede uitgesproken bij de aanvaarding van het ambt van hoogleeraar in de radiologie aan de Geneeskundige Hoogeschool te Batavia op den 21en maart 1929* (Weltevreden, [1929]), p. 3.



DER KONINGIN
UTRECHT

SIGNALEMENT.

Ouderdom 35 jaren.
Lengte 1.60 meter.
Voorhoofd gewoon.
Haar donker blond.
Wenkbrauwen donkerblond.
Baard —
Knevel blond.
Oogen blauw.
Neus gewoon.
Mond gewoon.
Kin gewoon.
Aangezicht rond.
Kleur gezond.
Bijzondere teekenen —

18. Bernardus Jan van der Plaats, proof of Dutch citizenship, 15 Nov 1923. Courtesy of Dr med. Gerardus J. van der Plaats, Maastricht.

health of radiologists. Talented men—Heinrich Ernst Albers-Schönberg, Jean Alban Bergonié, and his radiologist precedessor at Batavia, Max Hermann Knoch, Sr—had died "on the field of honor" from overexposure to radiation.

Knoch's career provides an illustration of the ambitions of Dutch medical scientists in the Indies. Born in Paramaibo, he studied at Leiden and became a physician there in 1894. The next year he signed on as an Indian health officer. He served in various outlying hospitals before landing at Batavia, where he rose to become *chef* of the military hospital and garnered the officer's cross in the Order of Oranje-Nassau. He took his pension in 1917 and travelled to Europe for additional study, receiving a complimentary medical doctorate from the University of Cambridge. With this new expertise, he returned to the Indies, this time as a radiologist in the public health service. Cancer, induced by radiation, took Knoch's life by inches. In 1918 surgeons amputated three fingers on his left hand, in 1922 two fingers on his right hand, and in 1928 his entire left arm.[115] He devoted his last months to improving radiological instrumentation.[116]

Radiological equipment *circa* 1928, Van der Plaats recalled later, suffered from indifferent supervision. In one case, the X-ray equipment had begun to smolder from carbonization of the rectifier's insulation. An electrician rewired the machine and caused plates taken of the extremities to be overexposed. Other installations, which could have been used on internal organs, saw use only on the extremities. In some measure this situation resulted because no factory-trained technicians lived in the Indies; and although physicians had an elementary grasp of radiology, none understood—as few understood in the Netherlands—the electrical side of X-ray equipment. European-manufactured instruments required constant and expert attention, because although firms tested their products in so-called 'tropical rooms,' artificial conditions could not reproduce the long-term effects of humidity and insects. Some of the problems with radiological instruments stemmed from the absence of constant-voltage power supply. When the instruments switched on, electrical surges often produced a "röntgen concert." Voltages would vary by as much as 20% during an exposure, and in one case no exposures could be made whenever the hospital used its electrical pump. Finally, inadequate ventillation shortened the operating life of many instruments.[117] Van der Plaats immediately started to renovate his radiological facilities. The best of the X-ray equipment in the main public hospital, he noted in 1929, "could be used as a reserve. . . [and] also for practice and training," but in general everything was "outdated." (He referred to machines constructed in the early 1920s.)

115 K. d. J., "In Memoriam M. H. Knoch," *GT*, *68* (1928), 625-6. The Cambridge degree bears the initials M. D. A. E.

116 M. H. Knoch, "Röntgenstereo-opnamen," *ibid.*, pp. 627-33.

117 Van der Plaats, "Werkwijze tot unificatie van röntgentechniek in Ned.-Indië," *GT*, *79* (1939), 3306-16, where he reviews the state of radiology in 1928.

The colonial medical authorities awarded him *f* 40,000 in the cause of modernization.[118] He nursed the grant as an intelligent researcher would. Instead of purchasing premanufactured machines from Europe, he chose to build his own high-voltage supply. In this way he established local technical expertise and, at the same time, modified temperate-climate equipment to function efficiently in the tropics.[119]

Just as the standards of higher education in the East Indies matched those of the Netherlands, so technical competence was not inferior to that of Europe. Van der Plaats labored with two European technicians to construct the new equipment. During the process of assembly, he frequently had to change rooms in the hospital. Because he maintained clinical X-ray services with the old machines, the new work often took place on Sundays or in the evenings.[120] Van der Plaats did all this while also instructing medical students and supervising radiology in other cities. In 1930 he advanced to a chair in radiology at the medical school. The high level of his instruction may be deduced from his required texts, including some by Americans Ernst Albert Pohle and Leo George Rigler.[121]

All therapeutic and diagnostic procedures, Van der Plaats knew, depended on a reliable measurement of radiation dosage.[122] So did the health of radiologists. Dosimeters from Europe or North America, the same as many of the early cosmic-ray counters, were notoriously inaccurate in the tropics. Everything went back to the proper construction and electrical isolation of the ionization chamber, through which passed the X rays to be measured, and the galvanometer, which provided a reading of the ionization current produced in the chamber. European manufacturers did not take into account the critical factor of tropical humidity. Following the tradition of Jacob Clay, Van der Plaats invented a reliable dosimeter, again with the assistants at his disposal. He assembled six ionization chambers and three different galvanometers. When on leave for ten weeks in the Netherlands in 1932, he calibrated the eighteen combinations of ionizer and counter with a standard dosimeter, which then went to Bonn for comparison against a primary standard. Back in Batavia, Van der Plaats persuaded himself that his instruments had survived the ocean voyage without a significant loss in accuracy. The dosimeter, easily modified, also served in radium therapy. Van der Plaats provided the Dutch East Indies with the first precise radiation standards in Asia.[123]

Van der Plaats's achievement of reliable standards formed the basis for his using radiation as cancer therapy. He believed in 1937 that X rays could

118 LP. Van der Plaats to Head of Public Health Service, 25 Feb 1929.

119 LP. Van der Plaats to Head of Public Health Service, 28 Dec 1930.

120 *Ibid.*

121 Batavia, Geneeskundige Hoogeschool, *Dertiende Jaarboekje* (Batavia, 1940), pp. 16-17.

122 For example, J. Cramer Hudson, "Roentgen-Ray Dosimetry," in Glasser, *Radiology* [note 57], pp. 120-38.

123 Van der Plaats, "Doseering van röntgen- en radiumstralen," *GT*, *73* (1933), 1490-6; the comparison according to von Ronnen [note 102].

duplicate the beneficial effects of radium, and at a fraction of radium's cost, provided that dosage could be delivered to the site of the carcinoma.[124] A year later, he reported that radiation-therapy units existed in seven Indonesian cities.[125] By 1939 the number of such units had passed a dozen.[126]

A man of higher learning in the Dutch colonies served many constituencies. Just as Jacob Clay lectured engineers on classical philosophy, so the physicist-physician B. J. van der Plaats turned his knowledge of X rays to deal with the problem of pulmonary tuberculosis, a field in which his brother Gerardus, a young medical doctor in the Netherlands, had also staked a claim.[127] In 1931 Van der Plaats became vice-chairman of the Central Association for the Control of Tuberculosis in the Netherlands Indies. At this time, the campaign against tuberculosis assumed the character of an international medical crusade, and by donning the surplice with the cross of Lorraine, Van der Plaats attracted attention to and funding for his radiological institutes. He compared the efforts of motherland and colony. Early in 1933, Van der Plaats noted, the Netherlands had more than 35 sanatoria, of which 28 had laboratories and X-ray installations; there were 109 more modest offices dealing with tuberculosis. One could not hope to reproduce the Dutch effort in the Indies; the social and cultural environment would not allow it. One could only take modest steps in the direction of controlling the disease.[128] In July 1939 he and several physician colleagues reported to a tuberculosis congress on technical and organizational developments in the crusade.[129] The next month, by a royal decree, Van der Plaats became a *ridder* in the Order of the Netherlands Lion.

While Van der Plaats crusaded for public health and taught radiology, what did Agathe van der Plaats-Keyzer do? She was, to be sure, mistress of a villa, a command that came naturally to the heiress. She had, at her home, a small astronomical observatory, constructed in 1931 by Bernardus. Her professional ambitions deferred to those of her husband, following the pattern set by Tettje Clay-Jolles several years previously at Bandung. As a condition of Van der Plaats's appointment in 1929, he obtained a directive empowering his wife to substitute for him in his medical and pedagogical

124 Van der Plaats, "Moderne Stralentherapie," *GT*, *77* (1937), 3084-91.

125 Van der Plaats, "Kanker en zijne bestrijding," *GT*, *78* (1938), 3122-35, on p. 3124.

126 Van der Plaats, "Werkwijze" [note 117], p. 3322.

127 G. J. van der Plaats, "De Voordeelen der gerichte longopnamen," *Nederlandsche Tijdschrift voor geneeskunde*, *78* (1934), 3014-18. G. J. van der Plaats became one of the foremost Dutch radiologists. Van Wylick, "Beiträge" [note 108], pp. 86-8.

128 Van der Plaats, *Röntgenologie en longtuberculose: Rede uitgesproken bij de zevende herdenking van den Dies natalis der Geneeskundige Hoogeschool te Batavia op 16 Aug. 1934* [Weltevreden, 1934], reprinted from the *GT*, *74* (1934), statistics on p. 16 of the reprint.

129 The lectures delivered before the congress appear in the *GT*, *79* (1939), the December number. Van der Plaats gave two: "Mogelijkheden en waarde van het röntgen-onderzoek bij tuberculose in Nederlandsch-Indië," 3290-3305; "Werkwijze" [note 117].

tasks when he would be touring the archipelago on inspection.[130] Upon his promotion to a chair of radiology, the departement of education and spiritual affairs did not explicitly renew the arrangement, although Van der Plaats regularly called on his wife to help him. In 1935 Van der Plaats chose not to take sabbatical leave in the Netherlands, but he persuaded the regime to send his wife back for a year. Agathe van der Plaats-Keyzer returned to Batavia in 1936 and stood in for an Indonesian physician at the radiology section of the main public hospital. Her credentials having been tested in a junior capacity, Van der Plaats named her as his replacement in the medical school when, in August 1936, he left for a year's absence in the Netherlands. No money changed hands as a result of the appointment, although the academic authorities praised the irregular woman professor.[131] Three years later the medical professors allowed her to become an assistant in radiology, again without salary.

It seems reasonable to conclude that the state authorities are not entirely to blame for exploiting the talents of Agathe van der Plaats-Keyzer. To use the case of Tettje Clay-Jolles as a measure, her salary would have netted only a small percentage increase in the family income. A civil servant's life is controlled by regulations and paperwork. In early twentieth-century Indonesia, as elsewhere, talented individuals would readily seek affiliation with an institution of higher learning but not want to be bound by its intrigues and conventions. We know that Agathe van der Plaats-Keyzer was in no great hurry to open a private medical practice in Batavia: She, the same as her husband, received such a medical license only in 1933. Women held the equivalent of professorial posts during the Dutch regime, and a number of women physicians—with medical doctorate and without—rose to positions of social prominence. Upon his arrival in Batavia, Van der Plaats had, as a salaried radiological assistant at the main public hospital, a Mrs J. M. Brouwer-van der Horst.[132]

The Van der Plaatses stayed at their posts through war and revolution. They, along with many other expatriates, died in the Netherlands. Medical radiologists in Indonesia continue a tradition established when Batavia belonged to the fraternity of Dutch medical schools.[133]

130 LP. The arrangement is recounted in a circular letter from Van der Plaats to the Medical Faculty, 2 Oct 1939.

131 LP. Bt 16 Jan 1937, N° 61, authorizing the appointment; Dean of the Medical School to Van der Plaats-Keyzer, 19 Mar 1937, thanking her for her service.

132 On the eve of the creation of the medical school, the regular teaching staff at Stovia (only one of whom merited a professorial title) included Miss M. van de Water, *docent* of nursing. *Ontwikkeling*, p. 366. According to Bt 26 Oct 1935, N° 11 (LP), among fifteen members named to a Tuberculosis Study Commission were B. J. van der Plaats and three women physicians: Miss Dr Ch. Flaumenhaft, public health physician in Semarang; Miss. J. A. de Jonge, missionary physician in Modjowarno; and Mrs M. J. Otten-van Stockum, public health physician in Bandung. LP. Bt Public Health Service 25 Dec 1928, N° 34921, concerning Van der Plaats's salary; Brouwer's salaried status is inferred.

133 Batavia was far from the least distinguished member of the fraternity. Compare the Free University of Amsterdam in *Universiteiten en hoogescholen* [note 11], pp. 27-8.

## Light in the Tropics

Medical licensing and medical treatment are, by their very nature, controversial. Public health depends on procedures and protocols that are in some measure unreasonable. The state confers exclusive powers on a small, self-regulating elite, the members of which enjoy a prestigious and comfortable living. Disagreements over therapeutic innovations may accordingly arouse passions across a wide spectrum of society. One such disagreement in the years around 1930 involved the principal lights of medicine, physics, and philanthopy in the East Indies. It centered around the claims of Denis Gérard Mulder regarding a cure for leprosy.

Mulder was a Bandung physician who completed a medical doctorate at Utrecht in 1923 about syphilis on Java.[134] With encouragement from philanthropist K. A. R. Bosscha and physicist Jacob Clay, he launched out into the new and poorly regulated field of medical radiology.[135] Following the tradition of phototherapy, he studied the curative uses of light.[136] In related (if not especially accomplished) publications, he emphasized the high-ultraviolet content of tropical light and its potentially beneficial effect.[137] Mulder then received lavish funding from Bosscha for a medical radiological institute in Bandung. Here Bosscha continued his special tradition of giving: Rather than working with established authorities, he preferred to create new, private institutions captained by outsiders. Having just directed his philanthropical attention toward medical institutions, Bosscha agreed to provide Mulder with capital of *f* 50,000 and *f* 1000 per month for operating expenses. He visited the new institute once before, in 1928, he died.[138]

Mulder officially opened his Bosscha Lichtinstituut in March 1929, and within a year he had spent *f* 64,000. In his view, light was the magic ray that could cure malaria and especially leprosy. He announced spectacular cure rates based on little more than the use of ultraviolet lamps and sunlight. He claimed, furthermore, that his work received the approbation of Dutch physics in the East Indies. In a book on malaria, for example, he

134 Mulder, *De Invloed der moderne kultuur op het verloop der syphilis bij den Soendanees* (Dr med. diss., Univ. Utrecht, 1923).

135 Mulder, *Total-X-Fotos* (Bandung, 1927). Mulder dedicated this exhortation in favor of full-body radiology to Bosscha and Clay. Mulder, "Totaliteits-Radiographie," *NT*, *87* (1927), 220-9.

136 Mulder, "Lichttherapie der malaria," *4° NINC Hand.* (1926), pp. 310-12.

137 Mulder, "Over Antagonistischen Werkingen van het Indische zonlicht en van kunstmatige lichtbronnen—photografisch beoordeeld," *4° NINC Hand.* (1926), pp. 148-51 ff. Mulder, *Tropisch Licht: Zijn beteekenis voor geneeskunde en photographie* (Bandung, 1927); the book contains the earliest published citation, in all probability, of Clay's latitude effect (p. 56).

138 Mulder, *Het Kruis der leprozen: Critische beschouwingen over 30 jaar leprabestrijding: Toepassing en resultaten van nieuwe leprabehandelingen tevens eerste verslag Bosscha Lepra Licht-Instituut*. . . (Bandung, 1930, second printing), p. 59. On Bosscha's extensive support of the Netherlands Indies Cancer Institute and the Institute for Deaf-Dumb and Hearing-Impaired Children: M. [A. J.] K[elling], "Een Groot Bandoenger herdacht," *Mooi Bandoeng*, *6*, 12 (1938), 6-13.

cited a lecture delivered by Tettje Clay-Jolles at the Koninklijke Natuurkundige Vereeniging in September 1929. There Clay-Jolles identified Mulder as "the first" researcher who pointed to the strong ultraviolet component of tropical light. Mulder introduced Jan Boerema and Maarten Pieter Vrij's publication of 1929 as additional support for his contention that tropical sunlight was rich in ultraviolet, but he cited and supported the scathing criticism directed by biometeorologist Carl Dorno against Boerema and Vrij's results.[139]

The Clays, as we have seen, did not publish their results on ultraviolet radiation until 1933, and, although their data was incomplete it also spoke against Boerema and Vrij. By this time, Mulder had become embroiled in a controversy extending beyond the walls of academe. Bosscha's death having deprived Mulder of his patron, it became necessary for him to obtain government funding. The public health service, however, did not approve of the therapy dispensed at what Mulder came to call the Bosscha Leper Light Institute. The service sent two investigators, one of whom being its former radiologist Van der Plaats, to evaluate Mulder's cures; the investigators were unimpressed.[140] In 1930 the bank blocked Bosscha's remaining largesse, some *f* 16,000.[141] Mulder could not attend conferences in his field.[142] The light-therapist defended himself in a succession of pamphlets and monographs. By 1936 the matter had been debated in the colonial assembly and read into the record of the second chamber of the motherland. A petition calling for a dispassionate inquiry into Mulder's treatment circulated in the Netherlands.

A mimeographed version of the petition, with several hundred signatures, bears the name of Jacob Clay.[143] Clay remained, indeed, on Mulder's side. He wrote in 1932 that Mulder's work was well regarded by a number of physicians. Clay had enjoyed discussions with Mulder, and he was impressed by Mulder's "physical and technical insight." In Clay's view, Mulder was a "genial man" of "highstanding character." Clay interpreted Van der Plaats's antipathy toward Mulder as a "sorrowful *fiasco*" based on misplaced prejudice. Clay urged the government to support Mulder's fight against leprosy and in this way honor the commitment of funds that Bosscha had made.[144]

Clay flourished in Amsterdam; Boerema and Van der Plaats flourished in Batavia; Mulder seems not to have succeeded in either attracting government funding or, the easier feat, curing leprosy. But it would not be going too far to identify a common destiny for all the protagonists. The

139 Mulder, *Malaria* (The Hague/Bandung, 1931), pp. 85-8. For Boerema, Vrij, and Dorno, see chapter three.

140 Mulder, *Het Kruis der leprosen* [note 138], pp. 181-3.

141 Mulder, *De Hoogste Wet* (Bandung, 1934), pp. 24-5.

142 Mulder, *Quo vadunt? Aangeboden aan het Geneeskundig Tijdschrift voor Nederlandsch-Indië* (Bandung, 1931).

143 The petition, along with other broadsides and pamphlets, in LUB at 791 A-4.

144 LMB, Arch. 234 D. Clay to unknown, Nov 1932, copy.

scientific merits of their case—in cosmic rays, ultraviolet solar radiation, tuberculosis, and leprosy—devolved into technical wrangling that, ultimately, required additional observations over a long period of time. Funding and politics being what they were in the period leading up to the war, the larger questions associated with these fundamental phenomena remained unanswered.

The controversy surrounding Denis Mulder points to the extraordinary ambition of Dutch researchers on Java during the interwar period. At any one time there were perhaps a score of permanently situated scientists carrying out programs in the exact sciences. They read each other's publications and talked freely about scientific means and ends. Following a longstanding Dutch tradition whereby future *hoogleeraren* taught during the beginning of their career at secondary or technical schools, colonial physicists used a position in a medical school to further their research. By the 1930s, Van der Plaats had become a physicist principally by virtue of his doctor's title, and he was glad to have Boerema teach a subject that to him had become uninteresting (and in this way allow Boerema to receive a professorial appointment). He would not, however, share the field that had been mandated him by the colonial regime.

Van der Plaats's opposition to Mulder's research related less to the merit of Mulder's claims than to the threat posed by an entrepreneurial rival. His hostility finds a counterpart in Willem van Bemmelen's sabotage of Joan Voûte's astronomical observatory and in Pieter Bergsma's antipathy toward Elie van Rijckevorsel's magnetical survey. Colonial institutions stemmed directly from the solicitations of gentlemen and philanthropists, but colonial scientists with government appointments hesitated to welcome the activity of private adventurers. Dutch civil authorities worked to smooth ruffled feathers on both sides. Had Mulder not been so eccentric in his comportment and expansive in his claims, he might have received the government support that came to the rescue of his astronomer and geophysicist colleagues.

# 5

# Tenebrous Colonial Visions

## The Theatre of Pure Science

Whether, as has been claimed, the early twentieth-century 'ethical policy' benefitted the Netherlands,[1] its implementation coincided with the appearance of two antagonistic intellectual currents. On the one hand, by 1930 a number of elite, educational and scientific institutions had emerged in the front ranks of the world of learning; a small number of Indonesians (among whom Soekarno was one) could receive an uncommonly good grounding in science and consider a career devoted largely to research. On the other hand, the first third of the twentieth century also saw the birth of a national language and independence movement (in which Soekarno was active) and a renaissance of traditional cultural expressions. Implantation of abstract Western learning and regeneration of Javan modes of understanding both occurred in one climate. It is likely that Jacob Clay and Joan Voûte, when finished with their experiments and observations, could have gone to the center of Bandung for an evening of wayang purwa theatre—much as Bandung professors might do today.

Wayang purwa, one of Indonesia's stunning cultural achievements, is a shadow puppet show accompanied by a gamelan orchestra and (in a twentieth-century innovation) a pesinden, or women's chorus. Dozens, even hundreds, of puppets are manipulated and given voice by the puppet master, or dalang, during a performance lasting much of a night. The classical repertoire consists of 177 plays adapted from the Ramayana and Mahabharata epics, in which the Hindu myths receive new characters (for example, the Panakawan, or comic retainers) and new adventures. The plots are inflexible, allowing them to be followed by popular audiences even though the language is for the most part classical Javanese.[2]

Rigidity of plot is offset by improvisation on the part of the dalang and the niyaga, or orchestra members, who follow the direction of the drummer. As master of the action, the dalang may insert modern allusions into the dialogue to emphasize a moral lesson. Without appealing to a written score, the drummer leads the orchestra to follow the dalang's pace. The

1 E. H. Kossmann, *The Low Countries, 1780-1940* (Oxford, 1978), pp. 401-12, 670-1.

2 Molly Bondan, Teguh S. Djamal, Haryono Guritno, and Pandam Guritno, *Lordly Shades: Wayang Purwa Indonesia* (Jakarta, 1984). Clifford Geertz, *The Religion of Java* (Glencoe, Ill., 1960), pp. 262-80.

drummer may also comment on the action presented by the dalang and on the classical poems sung by the pesinden. His remarks usually take the form of heckling, and he sometimes sometimes elicits a reply from the audience.

Interactive musical drama is known in other cultures. The unique feature of the Indonesian wayang theatre derives from the gamelan orchestra. The thirteen niyaga play at least fifteen different kinds of instrument, including gongs and xylophones, double-ended drums, a bamboo flute, and a rebab, or two-stringed bowed lute. Each gamelan orchestra, tuned to a scale of non-equidistant intervals, has a unique sound that improves with age and stabilization of the crystalline structure in the bronze instruments.[3] The orchestra surrounds the pesinden, who sit behind the dalang. In classical wayang purwa, the entire mechanism of sound and shadows remains obscured from the audience, although with the twentieth century the performance may also be viewed from the wings, in the perspective of Ingmar Bergman's film, *The Magic Flute*.

As he manipulates his puppets, the dalang moves them from their resting places on the sides of his screen to the kotak, or wooden chest—the repository for a figure whose action has passed. The dalang invests each puppet with motion and character, in addition to voice. He can magnify and distort shapes by placing a puppet at various distances from and angles to the screen. He punctuates the dialogue and action by using wooden knockers and metal rattles. He is the center of the performance and its prime mover.

To view the development of colonial scientific institutions without an awareness of metropolitan pressures and commitments would be to understand wayang purwa only by its sounds and shadows. Plot and timbre could be recorded, but knowledge would be denied of the exquisite, jewelled puppets, and of the costumes of niyaga and pesinden. Number and kind of musical instrument could be divined, but there would be no information about the expressions or organization of the musicians. Most critically, the overwhelmingly central role of the dalang would be a mystery. How could one infer the existence of a single puppeteer instead of three stage hands and a narrator?

The discourse produced by Dutch colonial observatories and laboratories was a shadow projection of metropolitan models. This is not to say that the result was less pleasing or less significant than if the intricately formed models themselves had been exposed directly, for what shadow puppets lose in color they gain in being able to alter shape and size, as they are rotated and transported backstage. The shadow performance, both at close range behind the screen of the discourse and as perceived by distant viewers, equalled performances in major metropolitan theatres. Clay's activity in his Bandung laboratory is at least comparable with Van der

3 *Harvard Dictionary of Music*, ed. Willi Apel (Cambridge, Mass., 1969), "Java," *s. v.*

Waals the Younger's at Amsterdam or Julius's at Utrecht; Van Bemmelen's, Braak's, and Boerema's climatology surpassed what emanated from the KNMI at De Bilt.

The similarity between metropolitan and colonial performances derives from the circumstance that exact sciences admit little cultural variation. An opportunity exists for improvisation, embellishment, and innovation—the art of the dalang and the drummer, the introduction of new performers like the pesinden—but there is only one repertoire of scientific practice, grounded in the technology of precise experimentation and observation and in the formulation of increasingly sophisticated mathematical expressions. However mass may be held to vary with velocity—whether by Lorentzian electron theory, Einsteinian relativity, or Minkowskian-Fockian geometry—all modern physicists know the phenomenon. French, Chinese, and Argentine particle accelerators are designed with it in mind. Prejudices for angle of attack certainly exist, but the twentieth century has witnessed few, if any, authentic, 'national' schools of physical research—certainly nothing to compare with what happened in the qualitative sciences, music, and painting. For this reason, attention to small variations in the prosecution of exact sciences can reveal the uses of pure learning beyond the academy and the laboratory.[4]

We have seen some of these uses in Indonesia. Because scientists conceived, administered, and carried out research in the Dutch language, the exact sciences served as a sign to natives, colonists, and foreign powers of a permanent allegiance owed by the colony to The Hague. In the Dutch experience, pure sciences had a privileged connection to practical application; without compromising their independence and latitude of judgment, scientists extracted results from the environment which would increase the wealth of both the colony and the imperial seat. Metropolitan professors exploited the colonies as a sink for the tide of advanced students who swept through their laboratories and observatories. For men like Bolland, Eijkman, Van der Stok, Van Bemmelen, Braak, and Aernout de Sitter, colonial employment—honorable in itself—became a normal stage in a scientific career. These circumstances, however, did not determine the form taken by scientific discourse in the East Indies. Although Clay's discoveries in cosmic rays, Voûte's in double-star astronomy, and Vening Meinesz's in gravimetry depended on the contingencies that allowed their research to receive funding and on the peculiar location of Java, the colonial environment was only partly responsible for the design of their instruments; there is no trace of imperialist ideology or rhetoric in the

4 An attention to subtle variations distinguishes the Swedish analysis of cultural specificity in technology. In *Technological Development in China, India, and Japan: Cross Cultural Perspectives*, eds Erik Baark and Andrew Jamison (New York, 1986): Erik Baark and Andrew Jamison, "The Technology and Culture Problematique," pp. 1-34, on p. 32; Aant Elzinga and Andrew Jamison, "The Other Side of the Coin: The Cultural Critique of Technology in India and Japan," pp. 205-53, on pp. 205-9. I understand their orientation to be compatible with my own.

interpretation of what the instruments measured or observed.

Characterizing cultural imperialism of the exact sciences by a collection of its manifestations, however, would deprive the phenomenon of its central significance. Scientists responded to the technical demands of commercial and agricultural exploiters, but they sought to distinguish themselves clearly from the government engineers whose questions they fielded. Science certainly constituted part of the education given to Indonesians destined for positions in the bureaucracy, but facility in research had only a small place in the educational curriculum, even at the height of agitation for creating a Westernized elite of lower-case Europeans. In the Dutch experience, by the early decades of the twentieth century cultural imperialism was not merely the use of knowledge to achieve political or economic ends; it was the prosecution of that knowledge as an end worthy in itself and for all mankind.

Dutch physicists and astronomers in Indonesia carried with them a belief in the importance of pure scientific research. Their university training emphasized a disinterested approach to uncovering nature's laws, one where the practical use of knowledge would at best be an unpleasant necessity. The activity of accumulating data was preliminary to revealing a natural order that stood above culture, West or East. Apprehending this order would be the true measure of a civilized society. Pure science was not primarily an instrument for civilizing immature minds, in the Netherlands or on Java, although it did occupy a place in general education; it did not aim to provide the state with an arsenal for imperial domination in the colonies and civil control at home, despite the fact that scientists often labored at tasks set by politicians and admirals. Scientific activity exemplified life's highest virtues. It was, ultimately, a question of character and ethics.

Pure science constituted an important correlate of the pluralist vision of Dutch colonial rule, as this vision emerged by the 1920s. Around this time, the assertion of Dutch authority over much of the archipelago, and its instantiation by the paternalistic ethical policy, ceded to an attempt to create a unique mixture of East and West under the stewardship of benign and accomplished administrators.[5] Research in the exact sciences became part of the adminstrators' panoply—an essential marker of Western sensibility—not unlike the role played by literacy in classical Greek among the administrative elite of early nineteenth-century Europe. (Jacob Clay's *oeuvre* exemplifies, in fact, the close relationship between exact sciences and classicism.) Pure research was, for the colonial government, elaborate and sacred theatre.

The theatrical performances of the scientists were no less sophisticated than those of wayang purwa artists. Taking magnetical readings thrice daily, seeing to seismographs and rainfall gauges, sweeping the skies

5 Kossmann, *The Low Countries* [note 1], pp. 401-12 on the ethical policy, pp. 674-6 on the dualistic successor.

for double stars, these were all activities constrained by tradition and informed by distant, cultural directives; they had hidden and public parts, as well as an orchestra of players. What else would most Indonesians have seen in them except theatre? Photographic archives provide compelling images in this regard. When J. A. C. Oudemans travelled around the archipelago to observe eclipses during the third quarter of the nineteenth century, he invested himself with the traditional symbols of authority—palanquin and cane. Javan assistants at the Batavia observatory received distinguished-service medals and commemorative banquets. Jacob Clay's launchings of high-altitude balloons, in the 1920s and 1930s, served as pageants for residents of Bandung.

It is possible to view the theatre of science as epiphenomenal to the prosecution of scientific research, a spectacle designed to impress adolescents, functionaries, and subject peoples with the forces at the command of the colonial authorities. The wearing of academic cap and gown in Bandung and Batavia would, according to this view, signal that colonial professors were magistrates of natural law. The publication in the East Indies of many thousands of pages of climatological, astronomical, and biological data would, from this perspective, mark the implantation of metropolitan standards. Publication and pageantry in colonial science would then be no more than symbols designed to reinforce social domination. Colonial science would appear in schematic form as an outward representation of the political goals held by administrators and academics. Knowledge would be retailed through the external form of power. The theatrical display of science would produce flickering, transient images on the walls of Plato's cave.

This is what may be called the illusionary interpretation of scientific activity, where acceptance of new ideas is inflexibly keyed to the social status of the conceiver and his claque, where discourses are thinly concealed vehicles for promoting one or another prejudice about social order, where natural knowledge is a 'great fraud' perpetrated by agents of a ruling class or dominant caste. Such an interpretation, however, with its focus on scientific pageantry, cannot explain why scientists, imbued with a vision unrelated to colonial exploitation, gave life to their vision in a colonial setting. It would have the scientist actors be theatrical mountebanks.

In his analysis of the theatre-state in nineteenth-century Bali, Clifford Geertz has called into question the usual distinction between the outward displays of state power and the deep purpose of state domination. To make pomp a mere instrument of purpose, he affirms, is first to reify and then to mystify the state as a dark and devious beast. It is to make the "semiotic aspect of the state"—the signs and symbols of rule—"so much mummery." Proponents of such a misconception "exaggerate might, conceal exploitation, inflate authority, or moralize procedure." Geertz continues: "The one thing they do not do is actuate anything." The illusionists infer deep purposes for behavior that, in its particular form, appears whimsical at

best. Collective behavior, paradoxically disenfranchised from living people, is held principally to reinforce social order. In such a system, individuals are sleepwalkers, whose primitive passions are merely channeled and exploited by the rules of the political game. Geertz rejects this view and proposes that, to understand the Balinese state, one must understand the emotions surrounding state splendor and hierarchy of status. One must "elaborate a poetics of power, not a mechanics." The Balinese state "drew its force, which was real enough, from its imaginative energies, its semiotic capacity to make inequality enchant." These imaginative energies provided an engine for turning "'the struggle for power' in classical Bali into a continual explosion of competitive display" in myth, rite, art, and architecture.[6]

The competitive display of colonial scientific theatre permits a reading of cultural imperialism in just the way that Balinese ceremony informs an understanding of the Balinese state. The prosecution of exact sciences in the East Indies did not derive from colonial power; rather, power resulted from pure knowledge. Cultural imperialism is not simply a strategy conceived and perpetuated by councillors of state for extending or deepening their rule; it is a phenomenon that establishes the limits of imperialist power. It operates, to the extent that it does, because of the constellation of beliefs associated with the nineteenth-century notion of the advancement of pure learning.

The phenomenon is a politicizing of Francis Bacon's assertion that knowledge of the world implies practical mastery over it. It follows that the great Baconian fact-collecting programs of the nineteenth and early twentieth centuries were—in their Humboldtian guise—less fanciful schemes for the extension of imperialist power perpetrated on muddle-minded heads of state by devious scientific advisers, than they were essential displays for establishing the extent and the limits of imperialist control. Bacon's idols of the theatre are hardly in evidence among the projects of Dutch colonial physicists and astronomers.[7]

Metropolitan patterns of life are not infrequently reified on the periphery, especially in colonial settings. Much of colonialist mentality is a hypertrophism of comportment at the seat of empire. The theatre of pure science in Indonesia suggests a reinterpretation of the theatrical basis of modern university instruction. The university lecture has persisted less as a means of transmitting new knowledge or of codifying old knowledge than as a way of establishing the perimeter of rational inquiry.[8] New synthetic

6 Geertz, *Negara: The Theatre State in Nineteenth-Century Bali* (Princeton, 1980), quotations appearing on pp. 122-5.

7 On Bacon, Charles Webster, *The Great Instauration: Science, Medicine and Reform, 1626-1660* (New York, 1975), especially pp. 335-42; David Oldroyd, *The Arch of Knowledge: An Introductory Study of the History of the Philosophy and Methodology of Science* (Kensington [N.S.W., Australia], 1986), pp. 59-66.

8 Shigeru Nakayama, transl. Jerry Dusenbury, *Academic and Scientific Traditions in China, Japan,*

appreciations and perceptions emerge, accordingly, as much in the process of lecturing as in the preparation of lectures. The universe presented in lectures to undergraduates is a world away from the parade ground delimited in sharp barks to military recruits. The theatre of pure science on Java identifies, more clearly than other activities, how knowledge is power.

## Intentional Filiation: The Civilizing Imperative

In 1941, under the German occupation of the Netherlands, Leiden astronomer Jan Oort published a survey of young Dutch astronomers with positions abroad. His remarks summarized the results of a decades-long initiative at placing astronomical talent in strategic locations. Oort began with the Dutch triumph in South Africa. Willem van den Bos had just become director of the Union Observatory in Johannesburg. Van den Bos's Dutch colleagues Hendrik van Gent, Aernout de Sitter, and Willem Christiaan Martin were active in South Africa on Leiden's behalf, and De Sitter had succeeded Joan Voûte as director of the Bosscha Observatory on Java. Dirk Brouwer had just been named professor of astronomy and director of the Yale University observatory. For more than ten years Brouwer had worked with Yale's southern station in Johannesburg. Jan Schilt was professor of astronomy at Columbia University and director of the Rutherfurd Observatory in New York. Willem Jacob Luyten directed the astronomical observatory at the University of Minnesota. Peter van de Kamp directed the Sproul Observatory at Swarthmore. Gerard Kuiper was associate professor and a staff member at the Yerkes Observatory and its affiliate, the McDonald Observatory in Texas. Bart J. Bok was professor of astronomy at Harvard University and director of the office for research into the Milky Way at the Harvard observatory. Adriaan van Maanen had been at the Mt Wilson observatory for decades. Herman Zanstra was Radcliffe Travelling Fellow at Oxford and then observer at the Radcliffe Observatory in Pretoria. Johan Stein directed the Vatican observatory.[9]

Most of the overseas Dutch astronomers had studied under De Sitter and Hertzsprung at Leiden, although a few were products of Groningen. Hertzsprung—Danish-educated and German-acculturated—was largely responsible for the overseas appointments. He realized that English-speak-

*and the West* (1974; Tokyo, 1984), pp. 169-71, for the persistence of the "theatrical form" of instruction in the specialist universities of the nineteenth and twentieth centuries. Nakayama writes in Kuhnian terms: "Under the name of general education, there is a revival of pre-paradigmatic, 'theatrical' courses dealing with problems (e.g., theories of civilization) that are difficult to present in normal-science fashion, as either specialized or foundation courses."

9 Oort, "Jongere Nederlandsche Sterrekundigen op belangrijke posten in het buitenland," *HD, 39* (1941), 355-63. Zanstra took a doctorate at the University of Minnesota in 1923 and eventually succeeded Antonie Pannekoek at Amsterdam. H. de Groot, "Sterrenkunde," in *Geestelijk Nederland 1920-1940*, eds K. F. Proost and Jan Romein, 2 vols (Amsterdam, [1948]), *2*, 243-54, esp. pp. 247, 252-3 for the expansionist drive of Dutch astronomy, p. 251 for Zanstra.

ing astronomers, especially, had deficient theoretical sensibilities, a lack clearly perceived in North America by around 1920. For the Americans, theory came from Europe, notably German-speaking lands. The war, however, had ostensibly quarantined German science through a post-war 'boycott,' of which American astronomers such as George Ellery Hale were prominent supporters.[10] Hertzsprung served up neutral, English-speaking Dutch astronomers as acceptible substitutes for German savants. At the same time, he tried to secure a permanent presence in Dutch-speaking lands, notably the East Indies and South Africa. Just as the rise of modern Dutch astronomy would have been impossible without the high visibility and international perspective of De Sitter and Kapteyn, so it depended on the imperialist dreams of metropolitan academics.

The Dutch knew what they were after, and they had a realistic understanding of their chances. As Kuiper wrote to Hertzsprung in 1936, the young American astronomers were forging ahead, but among them he had "seldom seen the combination: thoroughness + hard work." In replying, Hertzsprung suggested that smugness underwrote American productivity: "Childlike self-complacency is not found only among Americans. But who knows how much less they would achieve if they did not have this assurance?"[11] Kuiper's and Hertzsprung's letters are filled with references to the spreading influence of Dutch astronomers. Kuiper wrote in 1935 that to find a position he had to fight against the perception "that there are too many Dutchmen in America; this has become explicit."[12] Hertzsprung countered: "The observation that many Dutch astronomers have come to America is certainly right, but that is because Dutch astronomers are good, and one can't blame them for that."[13] In looking to South Africa, Hertzsprung urged Van den Bos to accept a post at the Union Observatory because in so doing he would solidify Dutch-South African relations by showing that "the former Dutch colony has not yet become English.... The main thing are the cultural connections. But these contemplations lie somewhat outside astronomy, although the said relations will also be good for astronomy."[14] And, of course, the reverse would also hold: Dutch astronomy would be good for Dutch political interests.

Hertzsprung's efforts at spreading the culture of Dutch astronomy centered on the manifest accomplishments of his students. Brilliance was relatively less important for receiving an appointment as a civil servant in the colonies. As the example of the Batavia observatory illustrates, several generations passed before the authorities were entirely content to support pure scientific research. Advancement in government service came

10 On the boycott and its American proponents: Daniel J. Kevles, *The Physicists: The History of a Scientific Community in Modern America* (New York, 1978), pp. 139-54.

11 NYH. Kuiper to Hertzsprung, 14 Mar 1936; Hertzsprung to Keiper, 2 Apr 1936.

12 NYH. Kuiper to Hertzsprung, 20 Feb 1935.

13 NYH. Hertzsprung to Kuiper, 7 Mar 1935.

14 NYH. Hertzsprung to Van den Bos, 26 Jan 1928 and 27 Jan 1928, quotation from the latter.

through having demonstrated loyalty to the bureaucracy; research accomplishment, as in the case of H. P. Berlage, was insufficient ground for pecuniary reward. The colonial authorities ran their men of pure learning on a short leash.

The development of the Batavia observatory illustrates that the practical demands placed on colonial scientists related directly to commerce and agriculture. Rainfall had to be measured, weather predicted, and the time of day established. As we have seen, planters and merchant princes went beyond supporting research into practical problems by consistently anticipating government action in the realm of scientific activity. In the nineteenth century, elite groups of private individuals underwrote the Koninklijke Natuurkundige Vereeniging and Melchior Treub's laboratories at Buitenzorg; beginning around 1917, K. A. R. Bosscha and his circle brought into being the Bandung Institute of Technology and the Lembang observatory. These were in large part enterprises devoted to pure science. The men who delivered the funds believed not so much that pure science would solve the colony's practical problems, as P. A. Bergsma had argued in the 1860s and 1870s, but rather that pure science would bring lustre to colonial overlords and their bourgeois confederates in the metropolis. Bosscha's colonial astronomical association is typical in this regard. Providing funds for pure research allowed Bosscha, a failure at the Delft Institute of Technology, privileged access to the drawing rooms of polite society and the antechambers of political power. Not incidentally, Bosscha purchased the services and loyalty of researchers like Joan Voûte and Denis Mulder.

The annals of science indicate, then, that Dutch cultural imperialism had three components: an emphasis on excellence in research; loyalty to the government center, in the colonies and in the metropolis; the enlistment of pure science for the practical end of commercial exploitation and the spiritual end of civilizing the exploiters. Each component contributed to the prestige and credibility of a minor power that had to rely for its existence on the good will of Great Britain, Germany, and France. The ensemble permitted a tiny nation on the North Sea to rule an overseas empire larger and more culturally diverse than Europe.

To say that academic, administrative, and commercial interests were involved in Dutch cultural imperialism is to suggest that it could have been otherwise in different circumstances. We find substantial variation among the major powers. Secular and commercial interests did not create, on their own initiative, observatories or physical laboratories in German and French spheres of interest; the civil and military authorities had a hand in all such projects from the beginning. Emphasis on original research in pure science emerged at German-inspired institutions but not at French-inspired ones. The French, however, unlike the Germans, placed great emphasis on administrative allegiance to metropolitan authorities or, in colonies and mandates, their factotum. And Belgian cultural imperialism was essentially commercialist, unless the grand rhetoric of King Leopold's

society for the exploration of the Congo is to be taken at face value.[15]

If academics and politicians did not fully perceive the trefoil nature of Dutch cultural imperialism, it may be because the interests behind each component emerged clearly only in the last third of the nineteenth century. The research ethic became an essential part of Dutch academia some time after Germany had been infected with it; state-financed scientific commissions and non-teaching institutions in the exact sciences, long a feature of France, found permanent form around 1900; the Indies opened to planters and entrepreneurs in the 1870s, and the Netherlands experienced an industrial revolution after 1890. Coupled with these new developments was a fundamental ambivalence, on the part of Dutch administrators and scientists, about the importance of the Dutch language, a sensibility expressed as an outward-looking equanimity of spirit. Linguistic imperialism was absent from the equation.[16]

Broadmindedness is evident in analyses of the East Indies published during the last decades of Dutch rule, whatever may be thought of the motives behind them. One consequence has been the interpretation, current for generations, that Dutch imperialism differed in kind from that of the great European powers.[17] Another consequence may be found in a certain fatalism about the ultimate failure of the Dutch presence overseas. The fatalism is apparent in a model for tracing the progress of civilization proposed by Lourens Gerhard Marinus Baas Becking, a sometime director of the Buitenzorg botanical gardens and Leiden *hoogleeraar*, in the centenary festschrift of the Koninklijke Natuurkundige Vereeniging. Baas Becking had taken a doctorate at Utrecht in 1921 on the biological effects of radiation, and over the years his interests broadened from biological to societal growth.[18] In Baas Becking's view, progress from innocence, or Eugaia, could proceed by rational exploitation to a developed Trophegaia,

15 For Germany in early twentieth-century Samoa, Argentina, and China, *CIES*. For the two attempts at an Indochinese university and one attempt at an Ecole des Arts et Métiers in Shanghai, French penetration into French Canada, and the competing interests of Germans and French in Ecuador and Chile: Lewis Pyenson, "Pure Learning and Political Economy: Science and European Expansion in the Age of Imperialism," *New Trends in the History of Science*, eds Robert Visser, H. J. M. Bos, H. A. M. Snelders, and L. C. Palm (Utrecht, in press). On the French Jesuits in China, Lebanon, and Madagascar: Lewis Pyenson, "Pure Research, Jesuit Institutions, and Metropolitan Ambitions: The Evolution of French Policy Overseas, 1880-1940," *Actes du IV° Colloque, l'Influence en Chine de doctrines venues de l'Occident* (Taipei/Hong Kong/Paris, in press).

16 Jacob Christiaan Koningsberger, writing as colonial minister, contrasts American linguistic imperialism in the Philippines to Dutch acceptance of Indonesian languages in: Koningsberger, *Aspects généraux de la politique coloniale actuelle des Pays-Bas* (Liège, 1928).

17 An interpretation challenged in M. Kruitenbrouwer, *Nederland en de opkomst van het moderne imperialisme: Koloniën en buitenlandse politiek 1870-1902* (Amsterdam/Dieren, 1985).

18 Baas Becking, *Radiation and Vital Phenomena* (diss., Univ. Utrecht, 1921), under plant physiologist Friedrich August Ferdinand Christian Went; Bass Becking, with Leland S. Baker, *Studies on Growth, parts 1 and 2* (Stanford, 1926) [*Stanford University Publications, University Series, Biological Sciences, 4,* N° 2]. Baas Becking, *Gaia of leven en aarde: Rede uitgesproken bij het aanvaarden van het ambt van gewoon hoogleeraar aan de Rijksuniversiteit te Leiden op woensdag den 28en januari 1931* (The Hague, 1931).

by direct destruction to a Diaspora, or to something in-between by a combination of the two paths. Social organization proceeded in a complementary way from a bucolic agricultural community to a point between the poles of a totally industrial Brave New World, on the one hand, and a functionary state in the image of Alphonse Daudet's Port Tarascon, on the other hand. Around 1950, Baas Becking believed that the world had bent away from Trophegaia-Brave New World and toward Diaspora-Port Tarascon.[19]

The Dutch shadow-masters did not experience the deprivation accompanying Baas Becking's degenerative drift. In their private lives, the scientists were manor lords, with resources and personnel to carry out their commands. The structure of authority in the colonies was similar to that in the motherland, where institute directors exercised enormous discretionary power and where professors' wives ruled a household of servants, gardeners, and tutors. The difference lay in the aspirations and feelings of the ruled. In the Netherlands, laboratory assistants could rise to become laboratory directors, and gardeners or tutors could climb up to a university chair. In the Netherlands East Indies, the pinnacle of the colonial hierarchy was reserved for Dutch citizens.

Heritage, being the past bequeathed by posterity, is a consequence of discrimination and, often, malice. Scientific heritage, no less than that in literature and politics, is subject to revisionist interpretations. Because scientific and educational institutions are conservative by nature, however, they often survive political revolutions with few modifications. Such a perspective makes it less controversial to emphasize that Indonesia's place in the world of science stems from a past of remarkable Dutch institutions. Just as Indonesians celebrate the cultural legacy of Hindu, Buddhist, Chinese, and Arab cultures, so they may be proud of the scientific discourse produced during the final century of Dutch rule. This discourse is as authentic a part of Indonesia as the plot of wayang purwa, and its authors deserve an honored place in Indonesian history.

19 Baas Becking, "Over De Maatschappelijke Betekenis van de natuurwetenschap," in *Eeuw*, pp. 265-72, especially pp. 270-1. Baas Becking credits Brave New World to Julian Huxley, but this infelicity should not suggest that he lacked a sufficient appreciation of the dark side to Aldous Huxley's future society; Brave New World and Port Tarascon (a hypertrophied colonial dependency) are entirely comparable satires.

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## About the Author

Lewis Pyenson, trained as a physicist and a historian of science, has taught at the University of Montreal since 1973. He is associate editor of *Historical Studies in the Physical and Biological Sciences*, and he sits as a curator of the Osler Library for the History of Medicine at McGill University. He is the author of *The Young Einstein* (1985), *Cultural Imperialism and Exact Sciences* (1985), and *Neohumanism and the Persistence of Pure Mathematics in Wilhelmian Germany* (1983). He and his wife Susan Sheets-Pyenson have three children.